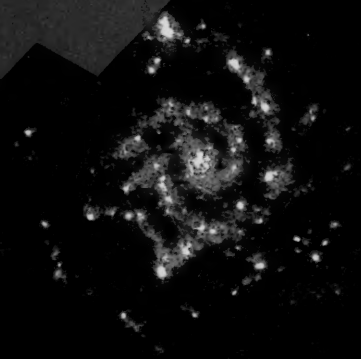
# Scientific and Technical Aerospace Reports

STAR



An Abstract Journal

Volume 31, Number 6
June 1993
N93-17809 to N93-19958

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Citations and abstracts of reports and publications that provide comprehensive coverage of worldwide aerospace-related topics including aeronautics and space science technology. *STAR* lists published and publicly available reports entered into the NASA STI Database during the four weeks preceding publication of this issue. These citations and abstracts are listed by subject categories.

**An Index Section**
- Subject
- Personal author
- Corporate source
- Contract number
- Report number.

**Appendix**
A guide for ordering cited reports, registering with the NASA STI Program, and using the available products and services. Additionally, price schedules, phone numbers, and addresses are included in this information packed section.

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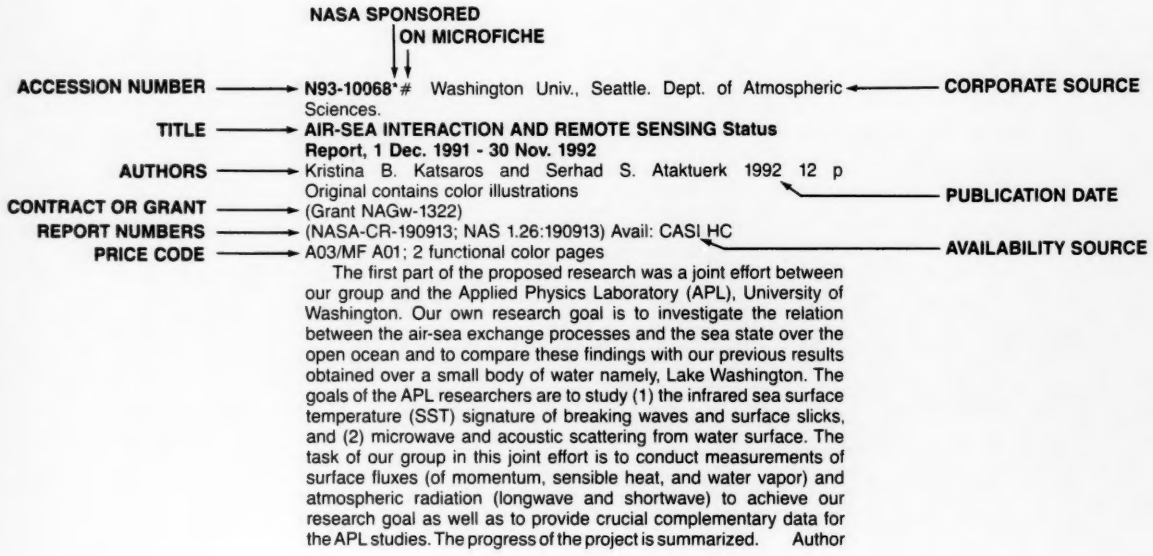

VOLUME 31 NUMBER 6 / JUNE 1993

# Scientific and Technical Aerospace Reports

A Monthly Publication of the National Aeronautics and Space Administration



## 01 AERONAUTICS (GENERAL)

**N93-17883*#** International Technical Associates, Inc., Drexel Hill, PA.
**OPEN AIRSCREW VTOL CONCEPTS**
W. Z. Stepniewski and T. Tarczynski Sep. 1992 226 p
(Contract NAS2-12819)
(NASA-CR-177603; A-93020; NAS 1.26:177603) Avail: CASI HC A11/MF A03

The following concepts, based on using open airscrew(s) for VTOL maneuvers, are re-examined in light of current technology: (1) tip-driven helicopters, (2) compound helicopters; and (3) high-speed VTOL aircraft, represented by tiltrotors, tiltwings, retractoplanes and stoppable rotors. Criteria, permitting one to compare performance of aircraft using diverse lifting and propelling methods are established. Determination of currently possible performance, indication of near-future potentials, and comparison of those items with the baseline levels (as represented by contemporary shaft-driven helicopters, first generation tiltrotors, and commercial turboprop fixed-wind aircraft) constitutes bulk of this report. Author

**N93-18109*** National Aeronautics and Space Administration, Washington, DC.
**AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 285)**
Dec. 1992 157 p
(NASA-SP-7037(285); NAS 1.21:7037(285)) Avail: CASI HC A08

This bibliography lists 534 reports, articles, and other documents introduced into the NASA Scientific and Technical Information System in Nov. 1992. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment, and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author

**N93-18887#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**AN INVESTIGATION OF THE INFLUENCE OF ADVANCED AIRCRAFT DIAGNOSTICS ON THE TECHNOLOGICAL SOPHISTICATION OF MAINTENANCE PERSONNEL M.S. Thesis**
Chris R. Collins and Clete W. Knaub Sep. 1992 114 p
(AD-A258988; AFIT/GLM/LSM/92S-9) Avail: CASI HC A06/MF A02

The purpose of this research was to determine what effect automated diagnostic systems will have on the maintenance worker's technological capabilities. Four investigative questions guided the project: (1) what effect has automation of skilled jobs had on workers in the civilian community?; (2) what technological and psychological traits have led to success in past military conflicts?; (3) what types of technological and psychological traits will technicians have who are heavily dependent on diagnostic systems? (for example, to what degree will maintenance technicians be able to improvise when deployed to a combat area?); and (4) what lessons can Air Force maintenance managers learn from the civilian community and past military experience? The study was conducted by performing a literature review of material from both military operational data and civilian data regarding automation and expert systems. Answers to the research questions were inferred from the collective resources studied. The study found that automation has impacted workers' technological capabilities in the past. Additionally, traits of successful technological workers were identified. Guidance helpful to managers and engineers implementing advanced diagnostics is also provided within the research. GRA

**N93-19002#** Technische Univ., Delft (Netherlands). Vakgroep Ontwerpen, Vliegmechanica en Ruimtevaart.
**PROFESSOR WITTENBERG: HIS SPECIALITY AND VERSATILITY [PROFESSOR WITTENBERG: ZIJN VAKGEBIED EN ZIJN VEELZIJDIGHEID]**
1991 89 p In DUTCH Symposium Amicorum held in Delft, Netherlands, 25 Jan. 1991
(ISBN-90-6275-670-0; ETN-92-92169) Copyright Avail: CASI HC A05/MF A01

Lectures concerning aircraft, given on the superannuation of Professor H. Wittenberg, are presented. Problems of propulsion and aerodynamic drag of aircraft are treated. The activities of Fokker in the field of aircraft performance are summarized. The applications of helicopters are outlined. Research activities in the field of propulsion systems for supersonic and hypersonic aircraft are overviewed. The status and prospects of the Dutch aerospace industry are presented. For individual titles, see N93-19003 through N93-19007.

**N93-19003#** Technische Univ., Delft (Netherlands).
**PROPELLING FORCE AND RESISTANCE [STUWKRACHT EN WEERSTAND]** **c02**
W. B. deWolf *In its* Professor Wittenberg: His Speciality and Versatility 1991 p 9-27 In DUTCH (For primary document see N93-19002 06-01)
Copyright Avail: CASI HC A03/MF A01

Some of the problems of propulsion and aerodynamic drag of aircraft are treated. The distinction is made between forces due to external flow and to the action of the engine (called internal flow), as well as between gross and net propulsion force. The problem of engine-airframe integration is very important, especially in the context of turbofan engines. Some examples are given of wind tunnel research on aerodynamic interference between the propulsion installation and the rest of the aircraft. ESA

**N93-19004#** Technische Univ., Delft (Netherlands).
**AIRCRAFT PERFORMANCE IN PRACTICE [VLIEGTUIGPRESTATIES IN DE PRAKTIJK]** **c05**
H. Wickardt *In its* Professor Wittenberg: His Speciality and Versatility 1991 p 29-41 In DUTCH (For primary document see N93-19002 06-01)
Copyright Avail: CASI HC A03/MF A01

The different activities within the Engineering Directorate of Fokker in the field of aircraft performance are summarized. The predesign division performs calculations for design studies, including alternatives of existing production programs as well as new projects. The division's operations provide customers with aircraft performance information, so that the customer may use their aircraft in a safe and economical manner. The Airline Analysis Division (of the Marketing and Sales Directorate) provides information concerning the performance of Fokker aircraft and their competitors'.
ESA

**N93-19005#** KLM Helikopters B.V., Amsterdam (Netherlands).
**HELICOPTERS IN ACTION [HELIKOPTERS IN AKTIE]** **c05**
H. W. C. L. Schoevers *In* Technische Univ., Professor Wittenberg: His Specialty and Versatility 1991 p 43-57 In DUTCH (For primary document see N93-19002 06-01)
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The use of helicopters is outlined. The individual performances of helicopters are unique, but the application domain is relatively small scale,

with the exception of military and offshore applications. The offshore applications are discussed. These applications include the following: air traffic control, processing of flight data, takeoff and landing, and the requirements for offshore transport. ESA

**N93-19006#** Technische Univ., Delft (Netherlands).
**WHAT IS THE PROGRESS IN PROPULSION? [ZIT ER VAART IN VOORTSTUWING?]** **c02**
P. A. O. G. Korting *In its* Professor Wittenberg: His Speciality and Versatility 1991 p 59-80 In DUTCH (For primary document see N93-19002 06-01)
Copyright Avail: CASI HC A03/MF A01

The activities of the TNO Prins Maurits Laboratory are outlined. These activities are mainly focused on propulsion systems for supersonic and hypersonic aircraft. The propulsion systems are based on rocket and ramjet techniques. There are civl and military research programs in the area of air breathing engines. The programs are for flight speeds from Mach 2 and higher. Pyrotechnical parts for the Vulcain engines of the European Ariane 5 launch vehicle were developed. Clean high energy and solid fuels are investigated. ESA

**N93-19007#** Technische Univ., Delft (Netherlands).
**INDUSTRIAL AEROSPACE ACTIVITIES [INDUSTRIELE RUIMTEVAART-AKTIVITEITEN]**
J. J. P. Groen *In its* Professor Wittenberg: His Speciality and Versatility 1991 p 81-95 In DUTCH (For primary document see N93-19002 06-01)
Copyright Avail: CASI HC A03/MF A01

The status and prospects of the aerospace industry in the Netherlands are presented. An historical overview of Dutch astronautics is given. The total turnover of the Dutch aerospace industry is estimated to be at least 150 million Dutch Guilders. The largest enterprise is Fokker Space and Systems; 30 percent of its turnover concerns commercial programs such as Ariane and solar panels for telecommunication satellites, 70 percent concerns institutional projects for ESA and the Dutch government. In the future, the market will be more oriented towards important aerospace applications such as telecommunication, Earth observation, navigation, and microgravity. ESA

## 02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

**N93-17809#** National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
**APPLICATION OF AN EULER-EQUATION METHOD TO A SHARP-EDGED DELTA WING CONFIGURATION WITH VORTEX FLOW**
H. W. M. Hoeijmakers and J. I. vandenBerg 13 Aug. 1991 18 p Presented at AIAA 9th Applied Aerodynamics Conference, Baltimore, MD, 23-25 Sep. 1991 Previously announced in IAA as A91-53801 Sponsored by Netherlands Agency for Aerospace Programs
(NLR-TP-91; ETN-93-92007) Avail: CASI HC A03/MF A01

The flow about a wing-body-sting configuration with a 65-deg sharp-edged cropped delta wing and an under-wing body is simulated by solving the Euler requations. Results are presented for the configuration at a Mach number of 0.825 and at incidences ranging from 10- to 20-deg. For this transonic free stream Mach number a strong leading edge vortex as well as shocks develop in the flow field above the wing. For the wing-body-sting configuration the numerical solution is investigated and computational results are compared with experimental data. The investigation includes the analysis of the complex flow pattern in the near wake. The influence of the under wing body on the flow field about the wing is assessed by comparing the solution for the complete configuration with the solution obtained for the wing alone on a grid similar to that for the wing-body-sting configuration. ESA

**N93-17819#** Naval Postgraduate School, Monterey, CA.
**A COMPUTATIONAL AND EXPERIMENTAL INVESTIGATION OF THE PROPULSIVE AND LIFTING CHARACTERISTICS OF OSCILLATING AIRFOILS AND AIRFOIL COMBINATIONS IN INCOMPRESSIBLE FLOW M.S. Thesis**
Kerry S. Neace Sep. 1992 123 p
(AD-A258019) Avail: CASI HC A06/MF A02

Computational and experimental methods have been used to systematically study one and two airfoils undergoing unsteady motion. First, a single airfoil analysis was done with the modified computer code, U2DIIF. Thrust, efficiency, and phase relationships were computed and compared to existing theoretical results. Furthermore, to help understand the dynamic stall process, relationships were developed between steady and quasi-steady pressure distributions for an airfoil undergoing a ramp motion. Next, an unsteady analysis for two airfoils was done with the modified computer code, USPOTF2. Again, thrust and efficiencies for interfering, harmonically oscillating airfoils were computed and compared to existing theoretical results. Furthermore, an analysis was completed on the effects of a harmonically oscillating airfoil on the pressure gradient of a stationary airfoil. Finally, flow visualization experiments were conducted using a low speed smoke tunnel at the Naval Postgraduate School (NPS). This experiment demonstrated the effects of a thrust producing, oscillating airfoil on the formation of the wake vortices. Furthermore, a flow visualization experiment was conducted in the NPS low speed wind tunnel, which demonstrated the beneficial influence of a secondary airfoil oscillating in the vicinity of a stationary airfoil at high angle-of-attack. GRA

**N93-17855*#** Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.
**HOT FILM WALL SHEAR INSTRUMENTATION FOR COMPRESSIBLE BOUNDARY LAYER TRANSITION RESEARCH Final Report, 1 Jan. 1991 - 1 Nov, 1992**
Steven P. Schneider 1992 214 p
(Grant NAG1-1201)
(NASA-CR-191360; NAS 1.26:191360) Avail: CASI HC A10/MF A03

Experimental and analytical studies of hot film wall shear instrumentation were performed. A new hot film anemometer was developed and tested. The anemometer performance was not quite as good as that of commercial anemometers, but the cost was much less and testing flexibility was improved. The main focus of the project was a parametric study of the effect of sensor size and substrate material on the performance of hot film surface sensors. Both electronic and shock-induced flow experiments were performed to determine the sensitivity and frequency response of the sensors. The results are presented in Michael Moen's M.S. thesis, which is appended. A condensed form of the results was also submitted for publication. Author

**N93-17880#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).
**AERODYNAMIC DESIGN AND ANALYSIS OF FANS USING 3D COMPUTATIONAL CODES [CONCEPTION ET ANALYSE AERODYNAMIQUE DE SOUFFLANTES A L'AIDE DE CODES DE CALCUL 3D]**
George Karadimas 1991 16 p In FRENCH Presented at 10th Congres Francais de Mecanique, Paris, France, 2-6 Sep. 1991
(DS-2140; ETN-93-93380) Avail: CASI HC A03/MF A01

The evolution of the design and analysis of high bypass ratio engine fans from an experimental basis to the use of digital simulation techniques is outlined. The choice of geometrical and aerodynamic parameters is considered together with the methodology for the design of the profiles and blades. Through achieved results, it is possible to directly correlate progress in computational fluid dynamics to fan performance improvements. The integrity of the fan is assumed by a mechanical analysis which interacts with the aerodynamics. Advantages of applying an aeromechanical approach to problems before carrying out the project are shown. The problems addressed include the following: the resistance of blades to ingestion of foreign bodies; and the prevention of supersonic flutter. It is concluded that digital techniques are beneficial and research should be continued along these lines. Three dimensional (3D) viscous flow and unsteady flow codes are already under development. ESA

**N93-17884*#** Sverdrup Technology, Inc., Brook Park, OH.
**A NUMERICAL STUDY OF MIXING IN SUPERSONIC COMBUSTORS WITH HYPERMIXING INJECTORS Final Report**
J. Lee Dec. 1992 22 p Sponsored by NASA. Lewis Research Center
Original contains color illustrations
(RTOP 505-62-40)
(NASA-CR-191027; E-7504; NAS 1.26:191027; AIAA Paper 93-0215)
Avail: CASI HC A03/MF A01; 4 functional color pages

A numerical study was conducted to evaluate the performance of wall mounted fuel-injectors designed for potential Supersonic Combustion Ramjet (SCRAM-jet) engine applications. The focus of this investigation was to numerically simulate existing combustor designs for the purpose of validating the numerical technique and the physical models developed. Three different injector designs of varying complexity were studied to fully understand the computational implications involved in accurate predictions. A dual transverse injection system and two streamwise injector designs were studied. The streamwise injectors were designed with swept ramps to enhance fuel-air mixing and combustion characteristics at supersonic speeds without the large flow blockage and drag contribution of the transverse injection system. For this study, the Mass-Averaged Navier-Stokes equations and the chemical species continuity equations were solved. The computations were performed using a finite-volume implicit numerical technique and multiple block structured grid system. The interfaces of the multiple block structured grid systems were numerically resolved using the flux-conservative technique. Detailed comparisons between the computations and existing experimental data are presented. These comparisons show that numerical predictions are in agreement with the experimental data. These comparisons also show that a number of turbulence model improvements are needed for accurate combustor flowfield predictions. Author

**N93-17928#** National Aerospace Lab., Amsterdam (Netherlands). Fluid Div.
**AERODYNAMIC ASPECTS OF OFFSHORE STRUCTURES**
E. Willemsen 13 May 1991 17 p Presented at 8th International Conference on Wind Energy, London, Ontario, 8-12 Jul. 1991
(NLR-TP-91188-U; ETN-93-93320) Avail: CASI HC A03/MF A01

The wind load characteristics of offshore structures were determined with a building block approach. Wind load data in a wide variety of body shapes are combined with procedures to describe major aerodynamic aspects, such as shielding, interference and flow field disturbances. Classical aerodynamic theories of wings were adapted for the typical geometrical characteristics of offshore structures and applied to describe the wind load behavior at tilted conditions. Extensive wind tunnel experiments on basic platform components and configurations were executed to verify and analyze the various aerodynamic aspects in the description of the wind loads. For tilted orientations the lift is shown to give significant contributions to the overturning moment and the induced drag; the wind axis roll angle has a negligible effect on the wind loads. Calculated results following the new approach agree fairly well with wind tunnel data and clearly compare favorable with respect to calculated results following guidelines of classification societies. ESA

**N93-17929#** National Aerospace Lab., Amsterdam (Netherlands). Aerodynamics Div.
**BEYOND THE FREQUENCY LIMITS OF TIME-LINEARIZED METHODS**
M. H. L. Hounjet and B. J. G. Eussen 13 Jun. 1991 17 p Presented at International Forum on Aeroelasticity and Structural Dynamics, Aachen, Germany, 1991
(NLR-TP-91216-U; ETN-93-93322) Avail: CASI HC A03/MF A01

Time linearized aerodynamic methods which usually operate in the frequency domain are known to suffer from frequency limitations especially in the transonic speed regime. Aerodynamic loads up to high frequencies are shown to be accurately obtained by applying methods which are based on exponentially diverging motions. A polynomial fit is made through the corresponding aerodynamic loads after which the fit is supposed to be valid also for general types of motion (analytical continuation). The convergence of iterative solvers in the aerodynamic methods is much improved, and a more than 50 percent reduction of computational cost may be achieved. It is further shown how existing time linearized methods which operate in the frequency domain can be modified to operate for diverging motions. Results of unsteady loads applications in two dimensional and three dimensional (3D) subsonic, transonic, and supersonic flow are shown. Results of an application to a 3D standard aeroelastic configuration in subsonic, transonic, and supersonic flow are presented. A description of the method of data fitting which was used in the examples is also given. ESA

**N93-17934*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**AN EXPERIMENTAL STUDY OF A TURBULENT BOUNDARY LAYER IN THE TRAILING EDGE REGION OF A CIRCULATION-CONTROL AIRFOIL Progress Report, 1 Sep. 1991 - 30 Sep. 1992**
K. Heinemann and Jeff Brown 8 Oct. 1992 7 p
(Contract NCC2-545)
(NASA-CR-191262; NAS 1.26:191262) Avail: CASI HC A02/MF A01

This report discusses progress made on NASA Cooperative Agreement NCC2-545, 'An Experimental Study of a Turbulent Boundary Layer in the Trailing-Edge Region of a Circulation-Control Airfoil' during the period 9/1/91 through 9/30/92. The study features 2-component laser Doppler velocimeter (LDV) measurements in the trailing edge and wake regions of a generic 2-dimensional circulation-control model. The final experimental phase of the study will be carried out in the Ames High Reynolds Number Channel 2 (HRC2) transonic blow-down-facility. During the 13-month period covered by this report, work continued on the development of the near-wall laser Doppler velocimeter (LDV) described in previous reports. Author

**N93-17991#** Defence Research Agency, Farnborough (England). Aerospace Div.
**HEAT TRANSFER AND AERODYNAMICS OF A HIGH RIM SPEED TURBINE NOZZLE GUIDE VANE WITH PROFILED END WALLS**
K. S. Chana Jul. 1992 10 p
(AD-A258346; DRA-TM-AERO/PROP-8; DRIC-BR-312886) Avail: CASI HC A02/MF A01

It has been shown that the secondary flows present within turbine nozzle guide vanes have a marked effect on heat transfer. The horse-shoe and passage vortices, for example, have a major impact on platform and vane suction surface heat transfer. To investigate these effects further, heat transfer and aerodynamic measurements have been made on an annular transonic turbine nozzle guide vane ring, with three different platform geometries. The measurements were taken in the Isentropic Light Piston test facility at RAE Pyestock at representative values of engine Reynolds number, Mach number, and freestream gas-to-wall temperature ratio. This paper compares and discusses the measured platform and vane suction surface Nusselt and Mach number distributions for the three different endwall profiles. Comparisons with theoretical flow and heat transfer predictions are presented. GRA

**N93-17994#** Scientific Research Associates, Inc., Glastonbury, CT.
**PROJECTILE BASE BLEED TECHNOLOGY. PART 1: ANALYSIS AND RESULTS Final Report, Jul. 1988 - Jul. 1991**
Howard J. Gibeling and Richard C. Buggeln Nov. 1992 84 p
(Contract DAA15-88-C-0040)
(AD-A258459; R91-930020-F; ARL-CR-2) Avail: CASI HC A05/MF A01

Detailed finite rate chemistry models for H2 and H2-CO combustion have been incorporated into a Navier-Stoke computer code and applied to flow field simulation in the base region of an M864 base burning projectile. Results without base injection were obtained using a low Reynolds number k-epsilon turbulence model and several mixing length turbulence models. The results with base injection utilized only the Baldwin-Lomax model for the projectile forebody and the Chow wake mixing model downstream of the projectile-base. A validation calculation was performed for a supersonic hydrogen-air burner using an H2 reaction set which is a subset of the H2-CO reaction set developed for the base combustion modeling. The comparison with the available experimental data was good and provides a level of validation for the technique and code developed. Projectile base-injection calculations were performed for a flat base M864 projectile at M(sub infinity) = 2. Hot air injection, H2 injection, and H2-CO injection were modeled, and computed results show reasonable trends in the base pressure increase (base drag reduction), base corner expansion, and downstream wake closure location. GRA

**N93-18128#** Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.

**THE AERODYNAMIC CHARACTERISTICS OF THE GOTTINGEN 797 AND WORTMANN FX63-137 AEROFOIL SECTIONS AT VERY LOW REYNOLDS NUMBERS M.S. Thesis**

A. M. Robinson Sep. 1990 133 p

(ETN-93-92999) Avail: CASI HC A07/MF A02

Two aerofoil sections, the Gottingen 797 and the Wortmann FX63-137, were tested over the low Reynolds number range 151,000 to 285,000. Both clean and ribbed sections were tested with the aim of investigating the change in performance as a result of different spanwise rib spacing. Details of the wind tunnel and tests performed are given together with the results. The Wortmann demonstrated larger lift, and larger lift to drag ratios, than the Gottingen. Further, the Wortmann only required a two deg incidence decrease to close the hysteresis loop, whereas the Gottingen required at least five deg. Introducing ribs into the aerofoil design reduced the performance characteristics of both sections. The Gottingen exhibited the same lift loss for all three chord spacings, whereas the lift to drag ratio loss increased with wider rib spacings. The Wortmann experienced less of a lift reduction than the Gottingen, the loss being slightly greater for wider rib spacings. Similarly, the lift to drag ratio decreased proportionally to the rib spacing, but less than the Gottingen. Both aerofoils experienced severe hysteresis reduction. ESA

**N93-18272#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.

**AN EXPERIMENTAL INVESTIGATION OF INTERACTING WING-TIP VORTEX PAIRS Technical Report, 1 Oct. 1990 - 30 Jun. 1992**

J. S. Zsoldos and W. J. Devenport 30 Jun. 1992 431 p

(Contracts N00014-90-J-1909; N00014-91-J-1773)

(AD-A258471; VPI-AOE-191) Avail: CASI HC A19/MF A04

The interaction of trailing vortex pairs shed from the tips of two rectangular wings were studied through helium bubble flow visualizations and extensive hot wire velocity measurements made between 10 and 30 chordlengths downstream. The wings were placed tip to tip at equal and opposite angles of attack, generating pairs of co-rotating and counter rotating vortices. Meaningful hot wire measurements could be made because the vortices were found to be insensitive to probe interference and experienced very small wandering motions. The co-rotating pairs were observed to rotate around each other and merge. Upstream of the merging location, the vortices have approximately elliptical cores. These are surrounded by the two wing wakes which join together around the two cores. Flow in the vicinity of the cores appears fully developed. During the merging process, the cores rotate rapidly about each other, winding the wing wakes into a fine spiral structure. Merger roughly doubles the core size and appears to produce turbulence over a broad range of frequencies. The counter rotating pairs move sideways under their mutual induction and slightly apart; their flow structure changing little with downstream location. These cores remain fairly circular and do not become fully developed within 30 chordlengths of the measurements. GRA

**N93-18275*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**REFLECTION TYPE SKIN FRICTION METER Patent**

Promode R. Bandyopadhyay, inventor (to NASA) (AS&M, Inc., Hampton, VA.) and Leonard M. Weinstein, inventor (to NASA) 12 Jan. 1993 6 p Filed 8 Aug. 1991 Supersedes 92N-10008 (30 - 1, p 2)

(NASA-Case-LAR-14520-1-SB; US-Patent-5,178,004;

US-Patent-Appl-SN-742238; US-Patent-Class-73-147; US-Patent-Class-73-9; Int-Patent-Class-G01M-9/00) Avail: US Patent and Trademark Office

A housing block is provided having an upper surface conforming to the test surface of a model or aircraft. An oil film is supplied upstream of a transparent wedge window located in this upper surface by an oil pump system located external to the housing block. A light source located within the housing block supplies a light beam which passes through this transparent window and is reflected back through the transparent window by the upper surface of the oil film to a photo-sensitive position sensor located within the housing. This position sensor allows the slope history of the oil film caused by and aerodynamic flow to be determined. The skin friction is determined from this slope history. Internally located mirrors augment and sensitize the reflected beam as necessary before reaching the position sensor. In addition, a filter may be provided before this sensor to filter the beam.

Official Gazette of the U.S. Patent and Trademark Office

**N93-18336#** Naval Postgraduate School, Monterey, CA.

**LIFT ENHANCEMENT USING A CLOSE-COUPLED OSCILLATING CANARD M.S. Thesis**

Dean C. Schmidt Sep. 1992 118 p

(AD-A257877) Avail: CASI HC A06/MF A02

A wind-tunnel study to investigate the effects of dynamic stall of a close-coupled canard on the canard/wing vortex interaction for increased lift enhancement was conducted. Two angles of attack of the model were studied: one at the first stall condition of the wing and one in the post-stall regime where a strong leading-edge vortex was formed. Baseline force and moment parameters were measured at mean canard deflections based on those determined to be optimum for the static case, as were mean values +/-3 degrees about the optimum. The amplitude of oscillation considered was +/-5 degrees about each mean; reduced frequencies tested were from 0.046 to 0.232. For most cases, lift was enhanced beyond the static-canard case at mean deflections equal to those at or greater than the static optimum value. The effective lift was decreased for mean deflections less than those previously determined to be optimum. Lift enhancements were generally 2 to 6 percent higher than the values determined with the static canard. The increased lift was generally independent of reduced frequency and peaked between k values of 0.1 to 0.2. GRA

**N93-18378*#** Eloret Corp., Sunnyvale, CA.

**HYPERSONIC FLOWS AS RELATED TO THE NATIONAL AEROSPACE PLANE Semiannual Report, 1 Sep. 1991 - 31 May 1992**

Marvin Kussoy, F. Menter, and P. G. Huang 30 Jul. 1992 6 p

(Contract NCC2-452)

(NASA-CR-191980; NAS 1.26:191980) Avail: CASI HC A02/MF A01

The study in the last 6 months has observed a clear evidence that the current two-equation models tend to under-predict flow separation and over-predict heat transfer rate near flow re-attachment regions. In hypersonic flow calculations, these model deficiencies appear to be even more pronounced. This is particularly true in the incapability of the model to predict the extent of the flow separation. Two major deficiencies of the current two-equation models in predicting complex hypersonic flows have been reported, i.e., under-prediction of flow separation and over-prediction of peak heat transfer rate. Two modifications to the k - epsilon model were reported and tested over a range of flows. Based on our limited study, the modified models have been found to give better agreements in both surface pressure and heat transfer predictions for several complex shock-wave boundary-layer interaction flows. However, in order to confirm our observation, more calculations will be performed in the future study covering a wider range of flows and conditions than reported here.

Author

**N93-18384*#** Tennessee Univ. Space Inst., Tullahoma. Center for Space Transportation and Applied Research.

**A WALL INTERFERENCE ASSESSMENT/CORRECTION SYSTEM Semiannual Report No. 3, Jul. - Dec. 1992**

Ching F. Lo, Glenn Overby, Cathy X. Qian, W. L. Sickles, and N. Ulbrich Dec. 1992 23 p

(Grant NAG2-733)

(NASA-CR-191889; NAS 1.26:191889) Avail: CASI HC A03/MF A01

A Wall Signature method originally developed by Hackett has been selected to be adapted for the Ames 12-ft Wind Tunnel WIAC system in the project. This method uses limited measurements of the static pressure at the wall, in conjunction with the solid wall boundary condition, to determine the strength and distribution of singularities representing the test article. The singularities are used in turn for estimating blockage wall interference. The lifting interference will be treated separately by representing in a horseshoe vortex system for the model's lifting effects. The development and implementation of a working prototype will be completed, delivered and documented with a software manual. The WIAC code will be validated by conducting numerically simulated experiments rather than actual wind tunnel experiments. The simulations will be used to generate both free-air and confined wind-tunnel flow fields for each of the test articles over a range of test configurations. Specifically, the pressure signature at the test

section wall will be computed for the tunnel case to provide the simulated 'measured' data. These data will serve as the input for the WIAC method--Wall Signature method. The performance of the WIAC method then may be evaluated by comparing the corrected data with those of the free-air simulation. Author

**N93-18395*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**WIND-TUNNEL FREE-FLIGHT INVESTIGATION OF A SUPERSONIC PERSISTENCE FIGHTER**

David E. Hahne, Thomas R. Wendel (McDonnell Aircraft Co., Saint Louis, MO.), and Joseph R. Boland (McDonnell Aircraft Co., Saint Louis, MO.) Washington Feb. 1993 63 p

(RTOP 505-59-30-07)

(NASA-TP-3258; L-17040; NAS 1.60:3258) Avail: CASI HC A04/MF A01

Wind-tunnel free-flight tests have been conducted in the Langley 30- by 60-Foot Wind Tunnel to examine the high-angle-of-attack stability and control characteristics and control law design of a supersonic persistence fighter (SSPF) at 1 g flight conditions. In addition to conventional control surfaces, the SSPF incorporated deflectable wingtips (tiperons) and pitch and yaw thrust vectoring. A direct eigenstructure assignment technique was used to design control laws to provide good flying characteristics well into the poststall angle-of-attack region. Free-flight tests indicated that it was possible to blend effectively conventional and unconventional control surfaces to achieve good flying characteristics well into the poststall angle-of-attack region. Author

**N93-18585*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

**SIMULATION OF UNSTEADY ROTATIONAL FLOW OVER PROPFAN CONFIGURATION Final Report, Jun. 1986 - 30 Nov. 1990**

Rakesh Srivastava and L. N. Sankar 30 Nov. 1990 9 p

(Grant NAG3-730)

(NASA-CR-192234; NAS 1.26:192234) Avail: CASI HC A02/MF A01

During the past decade, aircraft engine manufacturers and scientists at NASA have worked on extending the high propulsive efficiency of a classical propeller to higher cruise Mach numbers. The resulting configurations use highly swept twisted and very thin blades to delay the drag divergence Mach number. Unfortunately, these blades are also susceptible to aeroelastic instabilities. This was observed for some advanced propeller configurations in wind tunnel tests at NASA Lewis Research Center, where the blades fluttered at cruise speeds. To address this problem and to understand the flow phenomena and the solid fluid interaction involved, a research effort was initiated at Georgia Institute of Technology in 1986, under the support of the Structural Dynamics Branch of the NASA Lewis Research Center. The objectives of this study are: (1) the development of solution procedures and computer codes capable of predicting the aeroelastic characteristics of modern single and counter-rotation propellers; and (2) the use of these solution procedures to understand physical phenomena such as stall flutter, transonic flutter, and divergence. Author

**N93-18602*#** Iowa State Univ. of Science and Technology, Ames. Dept. of Aerospace Engineering and Engineering Mechanics.

**ANALYTICAL SOLUTIONS TO CONSTRAINED HYPERSONIC FLIGHT TRAJECTORIES**

Ping Lu 30 Nov. 1992 21 p Submitted for publication

(Grant NAG1-1255)

(NASA-CR-191987; NAS 1.26:191987) Avail: CASI HC A03/MF A01

The flight trajectory of aerospace vehicles subject to a class of path constraints is considered. The constrained dynamics is shown to be a natural two-time-scale system. Asymptotic analytical solutions are obtained. Problems of trajectory optimization and guidance can be dramatically simplified with these solutions. Applications in trajectory design for an aerospace plane strongly support the theoretical development. Author

**N93-18617#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

**PHOTOLUMINESCENT THERMOGRAPHY IN HYPERSONIC BLOWDOWN WIND TUNNEL: FEASIBILITY STUDY WITH PINPOINT MEASUREMENT Ph.D. Thesis - Caen Univ. [THERMOGRAPHIE PAR PHOTOLUMINESCENCE EN SOUFFLERIE HYPERSONIQUE A RAFALE: ETUDE DE FAISABILITE EN MESURE PONCTUELLE]**

Pierre Baumann 1992 202 p In FRENCH Original contains color illustrations

(ONERA-NT-1992-8; ETN-93-93079) Avail: CASI HC A10/MF A03

A method of thermography which is based on the heat sensitivity of a photoluminescent compound applied to the model/object being studied is considered. When excited by ultraviolet light, the luminescent pigment emits visible radiation. Certain qualities of this radiation depend, among other factors, on the temperature of the luminescent coating. The uses of this method are investigated, and the possibility of applying it to thermal measurements in blowdown wind tunnels is addressed. The thermometric possibilities of the chosen configuration, phosphor, and method of luminescent analysis, were first evaluated outside the wind tunnel, and a few of the parameters likely to influence the measurement were determined. Preliminary blowdown wind tunnel tests gave a global indication of feasibility, even if the time response in heat fluxes depends greatly on the adequacy of the thermal properties of the coating and of the model material. Image acquisition and digital processing techniques will be applied at a later stage, to establish a complete thermal mapping. ESA

**N93-18627#** Max-Planck-Inst. fuer Stroemungsforschung, Goettingen (Germany).

**NUMERICAL INVESTIGATION OF SWIRL-AIRFOIL INTERACTIONS IN TRANSONIC AREA Thesis [NUMERISCHE UNTERSUCHUNG VON WIRBEL-TRAGFLUEGEL-WECHSELWIRKUNGEN IM TRANSSONISCHEN GESCHWINDIGKEITSBEREICH]**

Klaus Ehrenfried Oct. 1991 154 p In GERMAN

(MPIS-8/1991; ETN-93-92730) Avail: CASI HC A08/MF A02

The two dimensional interaction between a vortex and an airfoil which characterizes the impulsive noise generated by helicopters is examined. The unsteady Euler equations were solved using a finite volume scheme on a triangulated instrument grid. The discretization was based on a conventional total variation diminishing method which was improved to reduce the numerical dissipation and to take into consideration the capture of shock waves. The vortex-airfoil interaction was investigated for various initial and boundary conditions. The numerical density distributions were compared with interferogram results from a wind tunnel experiment with a NACA profile. The computer distributions of vorticity and Mach number were analyzed. It is shown that the lift coefficient is not significantly modified by Mach number variations but the drag coefficient is strongly influenced by Mach number. ESA

**N93-18648#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 6: Calcul Scientifique, Modelisation et Logiciels Numeriques.

**A BLOTTNER TYPE NUMERICAL MODEL FOR NONEQUILIBRIUM VISCOUS HYPERSONIC FLOWS IN UPWIND FINITE ELEMENTS [UN MODELE NUMERIQUE DE TYPE BLOTTNER POUR LES ECOULEMENTS HYPERSONIQUES VISQEUX HORS-EQUILIBRE EN ELEMENTS FINIS DECENTRES]**

Nathalie Glinksy Jul. 1991 66 p In FRENCH Sponsored in part by Dassault Industries

(INRIA-RR-1476; ETN-93-92651) Avail: CASI HC A04/MF A01

A method for solving the Navier-Stokes equations augmented with a nonequilibrium dissociation model for the numerical simulation of the hypersonic blunt body flow as it occurs in the nose region of a space vehicle during its atmospheric reentry is presented. In a pseudo-unsteady approach, a mixed spatial discretization is used: upwind finite volume for the convective terms and centered P1 finite elements for the diffusive terms, applicable to unstructured triangular meshes. The viscosity, conductivity, and diffusion terms are calculated by the Blottner model. The extension of the second order accuracy is constructed via the MUSCL technique. The introduction of the species equations is realized in an uncoupled approach using an equivalent lambda. The production rate terms are treated implicitly. Several methods to calculate the convective terms

are compared. Numerical solutions of flows around blunt bodies and a double ellipse modeling of the European space shuttle Hermes are presented. ESA

**N93-18652#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 6: Calcul Scientifique, Modelisation et Logiciels Numeriques.

**INFLUENCE OF THE PHYSICAL MODELLING OF VISCOUS TERMS ON HYPERSONIC FLOW COMPUTATIONS [INFLUENCE DE LA MODELISATION PHYSIQUE DES TERMES VISQUEUX SUR LE CALCUL D'ECOULEMENTS HYPERSONIQUES]**

Maria Vittoria Salvetti and Massimo Passalacqua (Rome Univ., Italy ) Sep. 1991 55 p In FRENCH

(INRIA-RR-1493; ETN-93-92658) Avail: CASI HC A04/MF A01

Some aspects of the influence of the physical modeling of transport terms on nonequilibrium viscous flow computations are analyzed. In particular, the implementation of four different viscous models for the numerical solution of external hypersonic flows are addressed. The general flow equations for a gaseous mixture in chemical nonequilibrium and the employed chemical model are presented. The problem of modeling the transport terms from the kinetic theory of gases is detailed. Specifically, the Yos model, on which the transport coefficient calculation is based in the assumption of a binary mixture, is presented. With the numerical applications in mind, the description of four models of varying complexity is given. The discretization scheme applied to the numerical simulation of two dimensional external hypersonic flows is presented. The results obtained with the four models, for the blunt body and the double ellipse geometries in flow conditions similar to the conditions encountered by a space shuttle during the atmospheric reentry, are discussed. ESA

**N93-18701#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

**ELECTRON BEAM PROBING OF BLOW-DOWN HYPERSONIC FLOWS Ph.D. Thesis - Paris-Sud Univ. [SONDAGE PAR FAISCEAU D'ELECTRONS DES ECOULEMENTS HYPERSONIQUES EN RAFALES BREVES]**

Ajmal Khan Mohamed 1992 251 p In FRENCH Original contains color illustrations

(ONERA-NT-1992-7; ETN-93-93078) Avail: CASI HC A12/MF A03; 10 functional color pages

The feasibility of electron beam sounding of low density short lasting (approximately 20 ns) hypersonic flow is shown. Local and non intrusive measurements of density, vibrational and rotational temperatures and velocity in a low density flow of N2 or air are made with intensified optical multichannel analyzers. Detection of O2, N, O and NO were tried in the visible and near ultraviolet region; the NO molecule is found to be detectable through the NO(gamma) bands produced by the luminescent reaction with N2(A) metastables. Quantitative flow visualization using intensified charge coupled device cameras, in connection with a sweeping electron beam, seems to be possible to trace density contour maps of flow, insofar as the effects due to secondary excitations can be minimized. The use of a pulsed electron beam to tag a flow with plasma columns and spatial imaging of the movement of these luminous columns appears promising to measure the velocity and eventually to map the velocity field around a body set into the flow. ESA

**N93-18771*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.

**THE STABILITY OF A TRAILING-LINE VORTEX IN COMPRESSIBLE FLOW Final Report**

Jillian A. K. Stott (Manchester Univ., England ) and Peter W. Duck (Manchester Univ., England ) Washington Dec. 1992 55 p Submitted for publication

(Contracts NAS1-18605; NAS1-19480; RTOP 505-90-52-01)

(NASA-CR-189738; NAS 1.26:189738; ICASE-92-65) Avail: CASI HC A04/MF A01

We consider the inviscid stability of the Batchelor (1964) vortex in a compressible flow. The problem is tackled numerically and also asymptotically, in the limit of large (aximuthal and streamwise) wavenumbers, together with large Mach numbers. The nature of the solution passes through different regimes as the Mach number increases, relative to the wavenumbers. At very high wavenumbers and Mach numbers, the mode which is present in the incompressible case ceases to be unstable, while new 'center mode' forms, whose stability characteristics, are determined primarily by conditions close to the vortex axis. We find that generally the flow becomes less unstable as the Mach number increases, and that the regime of instability appears generally confined to disturbances in a direction counter to the direction of the rotation of the swirl of the vortex. Throughout the paper, comparison is made between our numerical results and results obtained from the various asymptotic theories. Author

**N93-18781*#** Eloret Corp., Sunnyvale, CA.

**AN EXPERIMENTAL INVESTIGATION OF THE SEPARATING/REATTACHING FLOW OVER A BACKSTEP Progress Research Report, 1 Mar. 1992 - 31 Jan. 1993**

Srboljub Jovic 31 Jan. 1993 21 p

(Contract NCC2-465)

(NASA-CR-192105; NAS 1.26:192105) Avail: CASI HC A03/MF A01

This progress report covers the grant period from March until the end of January 1993. Extensive data reduction and analysis of single and two-point measurements for a backward-facing experiment were performed. Pertinent results are presented in two conference papers which are appended to this report. The titles of the papers are as follows: (1) 'Two-point correlation measurements in a recovering turbulent boundary layer'; and (2) 'An experimental study on the recovery of a turbulent boundary layer downstream of the reattachment'. Author

**N93-18989#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A WIND TUNNEL STUDY OF MAGNUS EFFECTS ON A DIFFERENTIALLY ROTATING MISSILE M.S. Thesis**

Karen A. Naselius Dec. 1992 108 p

(AD-A258812; AFIT/GAE/ENY/92D-01) Avail: CASI HC A06/MF A02

This study investigates magnus effects on a non-firmed missile model which had three axially rotating sections that span at different rates. Five spin cases are examined; the mid section spinning only; the front and rear sections spinning only; all section spinning at the same speed; all sections spinning in the same direction with the mid section spinning at an additional ten revolutions per second; and all sections spinning with the mid sections spinning the opposite direction at an additional ten revolutions per second. These five cases are tested at three different spin rates for two different wind tunnel velocities. Since no research on differential spinning was found, potential flow theory of a single spinning cylinder is expanded to the differential spinning cases. Test results show that the measured Magnus forces and moments are much smaller than the potential flow predictions though most were in the predicted direction. Results also show that normal and axial forces are not affected by spin which agrees with Potential flow theory. GRA

**N93-19015*#** High Technology Corp., Hampton, VA.

**MODELING THE TRANSITION REGION**

Bart A. Singer Washington Feb. 1993 91 p

(Contract NAS1-18240; RTOP 505-59-50-01)

(NASA-CR-4492; NAS 1.26:4492) Avail: CASI HC A05/MF A01

The current status of transition-region models is reviewed in this report. To understand modeling problems, various flow features that influence the transition process are discussed first. Then an overview of the different approaches to transition-region modeling is given. This is followed by a detailed discussion of turbulence models and the specific modifications that are needed to predict flows undergoing laminar-turbulent transition. Methods for determining the usefulness of the models are presented, and an outlook for the future of transition-region modeling is suggested. Author

**N93-19053*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**UNDERWING COMPRESSION VORTEX ATTENUATION DEVICE Patent Application**

James C. Patterson, inventor (to NASA) 22 May 1992 7 p

(NASA-Case-LAR-14744-1; NAS 1.71:LAR-14744-1;

US-Patent-Appl-SN-886998) Avail: CASI HC A02/MF A01

A vortex attenuation device is presented which dissipates a lift-induced vortex generated by a lifting aircraft wing. The device consists of a positive pressure gradient producing means in the form of a compression panel

attached to the lower surface of the wing and facing perpendicular to the airflow across the wing. The panel is located between the midpoint of the local wing cord and the trailing edge in the chord-wise direction and at a point which is approximately 55 percent of the wing span as measured from the fuselage center line in the spanwise direction. When deployed in flight, this panel produces a positive pressure gradient aligned with the final roll-up of the total vortex system which interrupts the axial flow in the vortex core and causes the vortex to collapse. NASA

**N93-19273#** National Aerospace Lab., Tokyo (Japan).
**PROCEEDINGS OF THE NINTH NAL SYMPOSIUM ON AIRCRAFT COMPUTATIONAL AERODYNAMICS [DAI KAI KOUKUUKI KEISAN KUUKI RIKIGAKU SHINPOJUUMU RONBUNSHUU]**
Dec. 1991 334 p In ENGLISH and JAPANESE Symposium held in Tokyo, Japan, 12-14 Jun. 1991
(NAL-SP-16; JTN-92-80390) Avail: CASI HC A15/MF A03

The following topics were discussed: research activities on uses of computational grid method for flow simulations, numerical simulations of transitional flows, flows around airfoils and flying bodies, and flows inside pipes and air intake, hardware and operating system required for numerical wind tunnel, and applications of computational fluid dynamics in aircraft development. For individual titles, see N93-19274 through N93-19326.

**N93-19274#** Tokyo Univ. (Japan). Inst. of Industrial Science.
**LES TURBULENCE MODELING USING DNS DATA BASE [DNS DETA BESU WO MOCHIITA LES RANRYUU MODERINGU]**
Kiyoshi Horiuti *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 1-8 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

The Smagorinsky model has been commonly used in Large Eddy Simulation (LES) of turbulent flow. Although LES computations or a variety of flows using this model have yielded acceptable results, it was necessary to incorporate several modifications into the model: (1) the model constant was optimized in different flows; and (2) the damping function was used to account for near wall effects. These modifications were generally ad hoc. Besides, a poor correlation of Reynolds stress model value with the Direct Numerical Simulation (DNS) exact value was reported. The resented paper's major objective is to address these issues and propose a new model which mitigates previous model's drawbacks by determining the proper energy scale in the subgrid scale eddy viscosity coefficient correlating with the channel flow DNS data. Author (NASDA)

**N93-19275#** Fujitsu Ltd., Tokyo (Japan).
**A SIMPLE GRID GENERATION TECHNIQUE FOR HYPERSONIC FLOW AROUND COMPLEX CONFIGURATION [FUKUZATSU KEIJOU BUTTAI MAWARI NO CHOUONSOKURYUU NO TAME NO KANTANNA KOUSHI KEISEIHOU NI TSUITE]**
Yoko Takakura and Satoru Ogawa (National Aerospace Lab., Tokyo, Japan) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 9-14 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

A simple grid generation technique which makes the grid fit a complex inner surface boundary with concavity and convexity orthogonally and also fit an outer surface boundary, is proposed here to simulate hypersonic flows around complex configuration. This technique is constituted algebraically by improving the hyperbolic grid generation method and considering the geometry. It is shown that two grids around hypersonic vehicles, a NASA shuttle and a NASDA shuttle H-2 Orbiting PlanE (HOPE), are successfully generated by using this technique. Author (NASDA)

**N93-19276#** Mitsubishi Heavy Industries Ltd., Tokyo (Japan).
**COMPUTATION OF INTERNAL FLOWS USING UNSTRUCTURED TRIANGULAR MESHES [HIKOUZOU SANKAKUKEI KOUSHI NI YORU NAIBU NAGARE NO KEISAN]**
Hideo Fukuda and Kazuomi Yamamoto (National Aerospace Lab., Tokyo, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 15-19 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

Numerical methods using unstructured meshes, which are represented by the finite element method, caused a numerical instability in the computation of high Mach number flows with discontinuities (e.g., shock waves and contact discontinuities). In recent years, several researchers have developed solution algorithms using the unstructured meshes for high Mach number flows by introducing the upwind techniques which are well developed for the finite difference method. They have proposed the several methods to specify the distribution of variables in control volumes to construct higher order upwind schemes. However, the methods seem not to be well established especially for the 'cell centered' approach. In this paper, a procedure to construct higher order upwind schemes is examined, and the Van Leer's flux limiter is applied to the method. Computational results are presented to show the applicability of the method to high Mach number flows with shock waves. Author (NASDA)

**N93-19277#** National Aerospace Lab., Tokyo (Japan). Computational Sciences Div.
**NUMERICAL COMPUTATIONS USING MULTI-DOMAIN TECHNIQUE [FUKUGOU KOUSHI NI YORU SUUCHI KEISAN]**
Satoru Ogawa, Yasuhiro Wada, Tomiko Ishiguro, and Yoko Takakura (Fujitsu Ltd., Tokyo, Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 21-26 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

The multidomain technique is used to solve the whole flow fields around the combined configuration of space vehicles. Several computational grids are overlapped with each other in the computational domain, and the solutions are combined by the interpolation scheme at the boundary of each grid. The Total Variation Diminishing (TVD) scheme of finite volume and post processing type is used to solve the Navier-Stokes equations for hypersonic flow. The numerical computations are performed for two problems, i.e., NASA space shuttle external tank rocket booster and NASDA HOPE (H-2 Orbiting Plane)/H-2 rocket/rocket boosters, and it is shown the results of numerical simulation using the present methods are reasonable. Author (NASDA)

**N93-19278#** Nissan Motor Co. Ltd., Tokyo (Japan).
**NUMERICAL SIMULATIONS OF HYPERSONIC RAREFIED TRANSITION REGIME FLOWS: DSMC METHOD AND NAVIER-STOKES COMPUTATION [SENI RYOUIKI NAGARE NO SHIMYURESHON: DSMC HOU TO NABIA SUTOKUSU SUUCHI KAIHOU]**
Toru Shimada, Yasuhiro Wada (National Aerospace Lab., Tokyo, Japan ), and Katsuhisa Koura (National Aerospace Lab., Tokyo, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 27-32 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Numerical solutions of the Direct Simulation Monte Carlo (DSMC) method and the Navier-Stokes equation with a no-slip or a slip wall boundary condition are obtained for hypersonic rarefied monatomic gas flows in the transition regime (kn = 0.1 to 0.001) around a finite length parallel flat plate and a circular cylinder. A comparison among these numerical solutions indicates that the DSMC method is well applied to a fully continuum flow regime and the Navier-Stokes equation is applicable to the transition flow regime by the use of the slip wall boundary condition. Author (NASDA)

**N93-19279#** National Aerospace Lab., Tokyo (Japan).
**MONTE CARLO SIMULATION OF NORMAL SHOCK WAVE. PART 1: LENNARD-JONES POTENTIAL [SHOUGEKIHA NO MONTE KARURO SHIMYURESHON. 1: RENADO-JONZU POTENSHARU]**
Hiroaki Matsumoto and Katsuhisa Koura *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 33-35 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

The Velocity Distribution Functions (VDF's) in an argon normal shock wave of upstream Mach number 7.8 and temperature 16 K are calculated using the null-collision direct simulation Monte Carlo method. The Lennard-Jones (LJ) potential is employed as a realistic intermolecular potential, where the deflection angle for molecular collisions is calculated by an accurate quadrature scheme. Some comparisons between the VDF's of the LJ potential, Maxwell molecule, and Maitland-Smith potential are made. Author (NASDA)

**N93-19280#** National Aerospace Lab., Tokyo (Japan).
**RAREFIED GAS NUMERICAL WIND TUNNEL. PART 7: OREX [KIHAKU KITAI SUUCHI FUUDOU. 7: OREX]** **c09**
Katsuhisa Koura and Mikinari Takahira (Daiko Ltd., Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 37-40 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

The 'Rarefied Gas Numerical Wind Tunnel (RGNWT)' constructed with the universal code described using the null-collision direct simulation Monte Carlo method is used for the simulation of rarefied gas flows around the Orbital Reentry EXperiment (OREX) vehicle. Some aerodynamic characteristics and flow field properties are presented. Author (NASDA)

**N93-19281#** Nagoya Univ. (Japan). Dept. of Aeronautical Engineering.
**ANALYSIS OF A 2-D AIRFOIL MOTION FLYING IN-PROXIMITY-TO A WAVY-WALL SURFACE: LIFTING-SURFACE-METHOD [HAJOU HEKIMEN JOU WO TOBU NIJIGENYOKU NO UNDOU KAISEKI: YOURYOKU MEN RIRON]**
Shigenori Ando, Tetsu Sakai, and Kyoko Nitta *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 41-49 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

An analysis of a two dimensional thin airfoil motion is presented, for cases when it flies over and in proximity to a wavy wall surface in an incompressible inviscid flow. Lifting surface technique is used. The results of computation agree satisfactorily with ones of another scheme, which is based on a finite difference method. Efficient integral domain on the wall surface is carefully settled. Some computations are included which suggest effect of many parameters on Wing In Ground effect vehicle (WIG) sea worthiness. Author (NASDA)

**N93-19282#** Nagoya Univ. (Japan). Dept. of Aeronautical Engineering.
**ANALYSIS OF A 2-D AIRFOIL MOTION FLYING IN-PROXIMITY-TO A WAVY-WALL SURFACE: FINITE DIFFERENCE METHOD [HAJOU HEKIMEN JOU WO TOBU NIJIGENYOKU NO UNDOU KAISEKI: SABUNHOU]**
Kyoko Nitta, Shigenori Ando, and Tetsu Sakai *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 51-57 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

The lift on an airfoil flying over a wavy wall surface is calculated using a finite difference method, which was developed by J. Nakamichi to improve Low frequency TRANsonic flow solver for Two dimensional (LTRAN2) evolved by W. F. Ballhaus & P. M. Goorgian. In order to apply this LTRAN2 version to present problem, some manipulation on grid making system is needed. First, cases of a flat plate over a flat solid wall are calculated to check the coding prior to the cases of a moving wavy wall. Second, aerodynamic characteristics of a flat plate over a moving wavy wall are calculated, and third its motion is investigated. The calculated results are compared with those obtained by the lifting surface theory. The agreements are quite satisfactory. Author (NASDA)

**N93-19283#** Okayama Univ. of Science (Japan).
**DEVELOPMENT OF A BOUNDARY ELEMENT METHOD PROGRAM FOR NUMERICAL ANALYSIS OF SUPERSONIC UNSTEADY FLOW [KYOUKAI YOUSOHOU NI YORU CHOUONSOKU HITEIJOURYUU NO SUUCHI KAISEKI PUROGURAMU KAIHATSU]**
Yuichi Maruyama and Teruo Sawada *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 59-63 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

A boundary element method program for supersonic unsteady flow around arbitrary configurations has been developed. The fundamental formulation is based on Morino's method. Linear distribution of doublet is adopted to ensure the continuity of the strength on panel edges, while constant distribution is used for source. The numerical results are given for the cases of flows around oscillating cones. The real parts of the solutions are compared with the results of steady flow calculations and they are shown to be consistent with each other. Author (NASDA)

**N93-19284#** Kyushu Univ., Fukuoka (Japan). Dept. of Aeronautical Engineering.
**NUMERICAL CALCULATIONS OF SEPARATING FLOWS AROUND OSCILLATING AIRFOIL [SHINDOU SURU YOKUKATA MAWARI NO HAKURIRYUU NO SUUCHI KEISAN]**
Shigeru Aso, Atsuhiro Sakamoto (Nissan Motor Co. Ltd., Tokyo, Japan ), and Noriyuki Kanehira *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 65-70 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Dynamic stall phenomena have been investigated numerically by solving incompressible Navier-Stokes equations by a third order upwind scheme in order to reveal the flow structure and mechanism of dynamic stall. At first, separated flows around a wing section at fixed attack angle are calculated and the results show excellent agreements with experiments which are conducted by the present authors. Separated flows around oscillating airfoil in pitch are calculated by using moving mesh system. The flow conditions are selected from experiments. The calculated separated region is small in pitching up process; and it becomes large in a pitching down process. Quite different characteristics of flow patterns between in a pitching up and pitching down processes are obtained. The hysteresis curves of C(sub L) and C(sub M) in dynamic stall are also simulated in the present calculations. Author (NASDA)

**N93-19285#** National Aerospace Lab., Tokyo (Japan).
**NUMERICAL SIMULATION OF UNSTEADY LARGE SCALE SEPARATED FLOW AROUND OSCILLATING AIRFOIL [SHINDOUYOKU MAWARI NO HITEIJOU DAIKIBO HAKURIRYUU NO SUUCHI SHIMYURESHON]**
Koji Isogai *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 71-76 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Numerical simulations of dynamic stall phenomenon of NACA0012 airfoil oscillating in pitch near static stalling angle are performed by using the compressible Navier-Stokes equations. In the present computations, a Total Variation Diminishing (TVD) scheme and an algebraic turbulence model are employed for the simulations of the unsteady separated flows at Reynolds number of 1.1 x 10(exp 5). The hysteresis loops of the unsteady pitching moment during dynamic stall are compared with the existing experimental data. The flow pattern and the unsteady pressure distributions during dynamic stall are also examined in detail. The qualitative features of the dynamic stall phenomenon, such as the behaviors of the total lift and pitching moment and the formation of the leading edge separation vortex are well reproduced by the present computations. Author (NASDA)

**N93-19286#** Science Univ. of Tokyo (Japan).
**CALCULATIONS OF AERODYNAMIC FORCES ON A WING WITH THRUST USING BEM [KYOUKAI YOUSOHOU NI YORU SUIRYOKU TSUKI YOKU NO KUURIKI KEISAN]**
Mitsunori Yanagizawa *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 77-81 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

A procedure for the numerical solution of steady flow past a wing with fans is described using a boundary element method in potential flow. The effect of thrust is represented by doublet singularities. The method employs an aerodynamic panel code to simulate the flow of fan jet stream around an aircraft configuration. The configuration of a Vertical TakeOff and Landing (VTOL) transport in achieving a multijet lifting system is composed of lifting fans nested in the wing planform. The aerodynamic forces were calculated with the fundamental shape of 'fan in wing'. The result is that there are regions of negative lift behind the position of the lift fan on the wing. The general tendency of how they interact with the wing to produce the aerodynamic forces is understood. Author (NASDA)

**N93-19287#** Nippon Electric Co. Ltd., Tokyo (Japan). C and C Systems Research Labs.
**EVALUATION OF FINITE ELEMENT ANALYSIS ON THE PARALLEL SIMULATION MACHINE CENJU [HEIRETSU SHIMYURESHON MASHIN SENJU JOU NO YUUGEN YOUSOHOU]** **c39**
Toshiyuki Nakata, Yasushi Kanoh, Nobuhiiko Koike, Hidehito Okumura (National Aerospace Lab., Tokyo, Japan ), Kunihiko Ohtake (National

Aerospace Lab., Tokyo, Japan ), Takashi Nakamura (National Aerospace Lab., Tokyo, Japan ), and Masahiro Fukuda (National Aerospace Lab., Tokyo, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 83-89 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

This paper describes parallelization of Finite Element Methods (FEM) on the parallel simulation machine Cenju. One of the most time consuming problems in FEM which are to be investigated is nonlinear dynamic finite element analysis. The main loop of the nonlinear dynamic finite element analysis is the loop based on Newton-Raphson method which is composed of the following two stages, namely: (1) calculation of the stiffness matrix; and (2) solution of a set of linear equations. Generation of the stiffness matrix consists of: (Process 1) per element calculation in which the element stiffness matrix as well as the reactance force is calculated for each element; and (Process 2) accumulative calculation in which the element stiffness matrices are combined to form the global stiffness matrix. Two strategies were tried to parallelize Process 2 and by eliminating the serial bottleneck, a speed up of 48 on a 64 processor system was attained. For parallelizing solution of linear equations, two approaches were tried: (1) parallelizing Lower triangular matrix and Upper triangular matrix (LU) factorization; and (2) parallelizing conjugate gradient methods. The speed up by parallelizing LU factorization was low 2.9 using 7 processors. By parallelizing the conjugate gradient method a speed up of 36 on a 64 processor system was attained for a large scale matrix (8,904 x 8,904).
Author (NASDA)

**N93-19288#** National Aerospace Lab., Tokyo (Japan).
**NUMERICAL WIND TUNNEL: REQUIREMENTS AND THE OUTLINE [SUUCHI FUUDOU: YOUKYUU YOUKEN TO GAIRYAKU]** **c09**
Hajime Miyoshi *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 91-97 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

In this paper, it is shown that the Numerical Wind Tunnel (NWT) with an actual performance of more than 100 times higher than Fujitsu-VP400 is feasible using a multicomputer architecture and crossbar interconnection network.
Author (NASDA)

**N93-19289#** National Aerospace Lab., Tokyo (Japan).
**NUMERICAL WIND TUNNEL HARDWARE [SUUCHI FUUDOU NO HADOUEA]** **c09**
Hajime Miyoshi, Yoshiro Yoshioka (Fujitsu Ltd., Tokyo, Japan ), Masayuki Ikeda (Fujitsu Ltd., Tokyo, Japan ), and Moriyuki Takamura (Fujitsu Ltd., Tokyo, Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 99-106 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

In a few years, a computer which processes Computational Fluid Dynamics (CFD) programs over 100 times faster than the Fujitsu-VP400 and has a main memory capacity of more than 32 G bytes will be required for CFD technology to play an important role in aerospace research and development. A distributed main memory parallel processor is free from the memory throughput bottleneck which prevents the implementation of shared memory parallel processors with the necessary speed. In the light of regular characteristics of CFD codes, a distributed memory parallel processor is likely to deliver the above mentioned processing speed. Its characteristics include a physically distributed main memory which logically provides programmers with global and local memory views, processing elements with high speed Reduced Instruction Set Computer (RISC) scalar units and high speed vector units with large capacity vector registers, and a crossbar network which interconnects a large number of processing elements. Such a processor can be suitably called the 'Numerical Wind Tunnel'. This paper describes the basic main memory structure, system configuration, processing element, and interconnection network and communication mechanism of the Numerical Wind Tunnel.
Author (NASDA)

**N93-19290#** National Aerospace Lab., Tokyo (Japan).
**THE OPERATING SYSTEM FOR NUMERICAL WIND TUNNEL [SUUCHI FUUDOU NO OPERETEINGU SHISUTEMU]** **c09**
Masahiro Fukuda, Kazuyo Suematsu, Masako Tutiya, Akira Ozora (Fujitsu Ltd., Tokyo, Japan ), Takashi Kunai (Fujitsu Ltd., Tokyo, Japan ), and Yoshinori Sakamoto (Fujitsu Ltd., Tokyo, Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 107-113 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Numerical Wind Tunnel (NWT) is a Computational Fluid Dynamics (CFD) oriented parallel computer system with distributed memory. Conventional Operating System (OS) has been developed mainly based on computers with shared memory. Each processor of NWT has its own individual OS and each OS needs to work in collaboration with each other. Therefore OS itself has a characteristic of programs processed in parallel. In this paper, OS functions required for NWT is discussed with the parallelism of OS taken into account to attain effective managements of hardware resources and high speed processing of CFD programs.
Author (NASDA)

**N93-19291#** National Aerospace Lab., Tokyo (Japan).
**THE LANGUAGE PROCESSOR SYSTEM FOR THE NUMERICAL WIND TUNNEL [SUUCHI FUUDOU NO GENGO SHORI SOFUTOUEA]** **c09**
Masahiro Fukuda, Takashi Nakamura, Masahiro Yoshida, Shin Okada (Fujitsu Ltd., Tokyo, Japan ), and Syuichi Nakamura (Fujitsu Ltd., Tokyo, Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 115-121 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

The Numerical Wind Tunnel (NWT) is under research and development by NAL and Fujitsu joint activity. It is a parallel computer system of distributed memory architecture composed of vector processors, whose goal is to perform Computational Fluid Dynamics (CFD) simulation about 100 times faster than FACOM-VP400. In this paper three fundamental functions global data, parallel execution of DO-loop, and data decomposition and allocation, which the language processor system has to provide in order to realize parallel execution on the NWT are shown. FORTRAN77 is chosen as a basic programming language for NWT and some compiler directives is added to make effective use of the NWT. In this paper, the programming model of the NWT and the execution image with these directives are explained.
Author (NASDA)

**N93-19292#** National Aerospace Lab., Tokyo (Japan).
**GENERATION OF LONGITUDINAL VORTICES IN SUPERSONIC FLOW [CHOUONSOKURYUU NI OKERU TATEUZU NO KEISEI]**
Toshiyuki Nomura, Ryuji Ishii (Kyoto Univ., Sakyoku, Japan ), and Michio Nishioka (Osaka Prefectural Industrial Technology Research Inst., Enokojima, Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 123-128 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

A key technology for developing scramjet engine is to mix fuel hydrogen and oxygen in supersonic airstream rapidly and efficiently. So far, intensive basic researches have been made to establish the supersonic mixing technology. As a means of enhancing mixing by increasing the contact area of two different gas species, it is proposed in this paper to generate longitudinal vortices with spanwise periodic cut-outs at the trailing edge of the wedge shaped fuel injector. Furthermore, the wake of a flat plate with the same cut-outs is investigated to clarify the formation of the streamwise vortices. Three dimensional Euler equations are solved for the two cases with Chakravarthy and Osher typed Total Variation Diminishing (TVD) scheme. The computational results in the first case shows that longitudinal vortices are generated a little downstream of the trailing edge, shed into wake, and entrain nearby fluid. This is an evidence of rapid mixing. The second results show flow fields similar to the first, which proves that the generation of longitudinal vortices is mainly governed by the geometry of the cut-outs at the trailing edge.
Author (NASDA)

**N93-19293#** Mitsubishi Heavy Industries Ltd., Tokyo (Japan).
**CODE DEVELOPMENT FOR HYPERSONIC REAL-GAS FLOW SIMULATIONS TOWARD THE DESIGN OF SPACE VEHICLES [KUURIKI SEKKEI TSURU TOSHITE NO GOKU CHOUONSOKURYUU KEISAN KODO NO KAIHATSU]** **c18**
Masahiro Nakao and Kozo Fujii (Tokyo Univ., Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec.

1991 p 129-133 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

Hypersonic flows over simple three dimensional bodies and a practical plane are simulated using a real gas Navier-Stokes code under an equilibrium air assumption. This code is based on three dimensional upwind flux splitting scheme with generalized Roe's Riemann solver. The real gas effect is incorporated using the Variable Equivalent Gamma (VEG) method. The equivalent gamma and other thermodynamic properties are calculated using empirical curve fits of equilibrium air. Numerical simulations are conducted for flow fields around a spherical blunt body, a hemisphere, as simple configurations, and H-2 Orbiting PlanE (HOPE: Japanese spaceplane) as a practical plane configuration. Flow conditions are Mach numbers of 7.72 for hemisphere, 15.0 for the blunt bodies and HOPE. Computed pressure and density distributions are presented. Results for simple configuration case is compared with experimental data for the code validation.
Author (NASDA)

**N93-19294#** Kawasaki Heavy Industries Ltd., Gifu (Japan). Technical Inst.
**THE ROLE OF COMPUTATIONAL FLUID DYNAMICS IN AERONAUTICAL ENGINEERING. 9: ANALYSIS OF HYPERSONIC EQUILIBRIUM AIR FLOW [SEKKEI NI OKERU SUUCHI KEISAN NO KATSUYOU NI TSUITE. SONO: GOKU CHOUONSOKU HEIKOURYUU NO KAISEKI]**
Takuji Kishimoto and Akira Hanamitsu (Kawasaki Heavy Industries Ltd., Kobe, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 135-140 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Numerical simulation of hypersonic flow around a two dimensional cylinder and a three dimensional complete reentry vehicle have been carried out by solving Euler and Navier-Stokes equations which incorporate the equation of state for an equilibrium air. The governing equations are solved by an implicit finite volume Total Variation Diminishing (TVD) upwind scheme using a two equation turbulence model for a viscous flow. Curve fits for the thermodynamic and transport properties of an equilibrium air adopted in order to estimate real gas effects. Convective fluxes are calculated by the Roe's approximate Riemann solver generalized for an equilibrium air. The results of hypersonic flow analysis using this code suggest that the real gas effects, such as chemical reaction, are not negligible to predict the hypersonic flow characteristics accurately. Author (NASDA)

**N93-19295#** National Aerospace Lab., Tokyo (Japan).
**COMPUTATION OF RE-ENTRY FLOWS WITH TWO-TEMPERATURE MODEL [2 ONDO MODERU WO MOCHIITA SAITOTSUNYUU BUTTAI MAWARI NO SUUCHI SHIMYURESHON]**
Yasuhiro Wada *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 141-147 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Calculations are made for the shock tube flows around a circular cylinder and wedges in order to clarify the effects of the modelings which are included in the two temperature model: preferential dissociation and diffusive vibrational relaxation. A vibrational relaxation model, which is valid at high temperature and doesn't have the information immediately behind the shock wave, is suggested. In addition, thermal nonequilibrium effects are investigated by flow simulations around an Orbital Reentry EXperimental (OREX) vehicle. Author (NASDA)

**N93-19296#** National Aerospace Lab., Tokyo (Japan). Aerodynamics Div.
**NUMERICAL CALCULATION OF HYPERSONIC NON-EQUILIBRIUM FLOW AROUND OREX [OREX MAWARI NO GOKU CHOUONSOKU KAGAKU HANNOU HIHEIKOURYUU NO KEISAN]**
Yukimitsu Yamamoto *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 149-152 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

Chemically, nonequilibrium Navier-Stokes (N-S) code, using the finite rate 7 species chemical reactions, is developed and applied for the analysis of Orbital Reentry EXperiment (OREX) vehicle. Three dimensional forebody flow fields, where the shock stand off distance is severely shortened by the high temperature real gas effects, are evaluated. In addition, near wake flows are investigated in detail by using the zonal grids approach.
Author (NASDA)

**N93-19297#** National Aerospace Lab., Tokyo (Japan). Aerodynamics Div.
**NUMERICAL SIMULATION OF HYPERSONIC FLOW AROUND H-2 ORBITING PLANE (HOPE), PART 3 [HOPE MAWARI NO GOKU CHOUONSOKU SUUCHI SHIMYURESHON, 3]**
Yukimitsu Yamamoto *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 153-157 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

Three dimensional upwind flux split Navier-Stokes (N-S) code is applied to the hypersonic flow around H-2 Orbiting PlanE (HOPE) 01 models. Numerical results were compared with experimental data of Numerical Wind Tunnel (NWT) and Calspan's shock tunnel. In order to study the aerodynamic environments of high Mach number area of HOPE flight trajectory, Mach number and real gas effects are analyzed by using the chemical nonequilibrium N-S code. Author (NASDA)

**N93-19298#** National Aerospace Lab., Tokyo (Japan).
**THE 3D NAVIER-STOKES CALCULATION OF FLOW ABOUT SCRAMJET INLET WITH STRUT [SUKURAMUJETTO ENJIN NO NAGARE NO SANJIGEN NABIA SUTOKUSU KAISEKI: SUTORATTO TSUKI KUUKI TORIIREGUCHI]**
Tomiko Ishiguro, Kazuyo Suematu, Yasuhiro Wada, and Satoru Ogawa *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 159-164 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

A numerical procedure to analyze a flow field through or around a Langley-typed scramjet engine inlet with a strut and an I-shaped thick cowl is proposed. To treat boundary conditions (wall, symmetry etc.) accurately, all boundaries are mapped onto faces of five rectangular parallelepipeds. The governing equations are the three dimensional full Navier-Stokes equations. The Total Variation Diminishing (TVD) scheme is applied for spatial discretizations and the Implicit Approximate Factorization (IAF) method, for time integration. To show capability of the numerical procedure, numerical simulations of flow have been carried out under Mach number 4 of free stream about four inlet models, whose struts differ in lengths but have the same contraction ratios. The result has made no great difference from each other in inlet performance such as mass capture ratio and total pressure recovery ratio. Author (NASDA)

**N93-19299#** Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
**NUMERICAL SIMULATION OF FLOW FOR A SCRAMJET NOZZLE [SUKURAMUJETTO NOZURU RYUU NO SUUCHI SHIMYURESHON]**
Taro Tsuyuki, Yasushi Hosaka (Tokyo Noko Univ., Japan ), and Fumio Higashino (Tokyo Noko Univ., Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 165-172 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

The objective of this paper is to compute the expansion of a supersonic flow through an internal and external nozzle and its interaction with the supersonic flow of free stream air. Furthermore, to calculate thrust and lift for a scramjet nozzle is attempted. The governing equations are the Navier-Stokes equations for two dimensional flows. The finite difference scheme employs an implicit upwind scheme. A turbulent model is adapted to the Baldwin-Lomax model. The diffusion, reaction and radiation of gas is neglected. Calculations are performed for the cases that have Mach number, temperature and pressure range at the combustor exit of 3,200 K and 1 to 2 atmospheres, respectively. The values on the outside of the afterbody and cowl are 3,500 K and 0.1 to 1 atmospheres respectively. The effects on the flow field, thrust and lift due to change of pressure, velocity and nozzle shape are studied. The results of the numerical calculations give different flow fields for underexpansion or overexpansion at the cowl exit. Consequently, the patterns of an asymmetric nozzle flow were found to be fixed by the degree of expansion at the cowl exit and

no perfect correct expansion were found to have existed in these flows. Furthermore, the internal flow of the nozzle in case of the overexpansion was found to be largely influenced by the flow of free stream air.
Author (NASDA)

**N93-19300#** Kyoto Univ., Sakyoku (Japan). Dept. of Aeronautical Engineering.
**A NUMERICAL SIMULATION OF FLOWS AROUND A DEFORMABLE GAS BUBBLE [HENKEI WO TOMONAU KIHOU MAWARI NO NAGARE NO SUUCHI KAISEKI]** **c34**
Minoru Sugano, Ryuji Ishii, and Shigeki Morioka *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 173-176 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

A numerical simulation of flows around a (deformable) gas bubble rising through an incompressible viscous fluid was carried out on a supercomputer Fujitsu VP2600 at Data Processing Center of Kyoto University. The solution algorithm is a modified Marker And Cell (MAC) method. For the grid generation, an orthogonal mapping proposed by Ryskin and Leal was applied. it is assumed that the shape of the bubble and the flow field are axisymmetric. Author (NASDA)

**N93-19301#** Nagoya Univ. (Japan). Dept. of Aeronautical Engineering.
**TRANSONIC FLOW CALCULATION AROUND NACA-0012 [NACA-0012 YLKU MAWARI NO SENONSOKURYUU NO KEISAN]**
Andi Eka Sakya, Yoshiaki Nakamura, and Michiru Yasuhara *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 177-184 (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Two turbulence models have been used to simulate a typical flow around NACA0012 at zero angle of attack. Those turbulence models are the Cebeci-Smith Model (CSM) and the Baldwin-Lomax Model (BLM). Analysis of these models in terms of turbulent boundary layer has also been carried out in which the differences in the predicted turbulent characteristics are made clear. The computed result is compared with the experimental data obtained from the transonic tunnel at Nagoya University.
Author (NASDA)

**N93-19302#** National Aerospace Lab., Kakuda (Japan). Research Center.
**SIMILARITY IN LAMINAR PIPE FLOWS WITH SECONDARY FLOWS [NIJI NAGARE WO TOMANAU KANNAI SOURYUU NO SOUJI HOUSOKU]** **c34**
Hiroshi Ishigaki, Hiroshi Tamura, Hitoshi Yamada, and Munekazu Mochizuki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 185-191 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Similarity in the fully developed laminar flows in curved pipe and orthogonally rotating pipe is discussed. Nondimensional parameters are obtained selected properly for each flow. It is shown that friction factors for these two flows are correlated by a single formula. Author (NASDA)

**N93-19303#** National Aerospace Lab., Kakuda (Japan). Research Center.
**FLOW AND HEAT TRANSFER CHARACTERISTICS OF ORTHOGONALLY ROTATING CHANNEL [KORIORI RYOKU TO ENSHIN FURYOKU GA SAYOU SURU KAITEN RYUURO NO RYUUDOU DENNETSU TOKUSEI]** **c34**
Hiroshi Tamura and Hiroshi Ishigaki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 193-196 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

Numerical analysis was conducted to predict the centripetal buoyant effect on flow and heat transfer characteristics in a channel rotating about a perpendicular axis. The conditions were assumed to be laminar, fully developed, and uniform heat flux. Calculation were conducted both for radially outward flow from the rotating axis and radially inward flow. The calculated results indicated that for radially outward flow buoyancy decreases the suction side friction and heat transfer while increasing pressure side friction and heat transfer. This trends were reversed for radially inward flow.
Author (NASDA)

**N93-19304#** National Aerospace Lab., Kakuda (Japan). Research Center.
**NUMERICAL TREATMENT OF LAMINAR FLOW IN CURVED RECTANGULAR CHANNELS WITH INLET AND OUTLET STRAIGHT REGION [SEIHOUKEI BENDO NAI NAGARE NO SUUCHI KAISEKI]** **c34**
Hitoshi Yamada, Hiroshi Ishigaki, and Munekazu Mochizuki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 197-203 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Developing laminar fluid flow in a curved square duct with inlet and outlet straight regions was studied numerically by using finite difference method. A power law scheme, a control method were used inside the computational domain. In this study, three bends were calculated, two were a 0 deg bend, and one was a 180 deg bend. A 0 deg bend flow had an one pair vortex secondary flow but in the case of 180 deg bend, it had a two pair vortex at higher deg regions than 120 deg from the duct inlet, which was caused by centrifugal force instability. Experimental data, of Shirakami, Inoue (90 deg bend) and Humphrey (90 deg bend) and Hille (180 deg bend) were compared with the calculated results. In the case of 0 deg bend, calculated results showed a good agreement with experimental results. In the case of 180 deg bend, it had also a good agreement, except the inlet and outlet region of the curved duct. This was considered that the inlet velocity was different from the experiment and the duct flow was assumed to have symmetric characteristics. However Hille's flow had an asymmetric vortex pattern across the duct section. Author (NASDA)

**N93-19305#** National Aerospace Lab., Kakuda (Japan). Research Center.
**NUMERICAL ANALYSIS OF FLOW IN A HEATED HORIZONTAL SQUARE DUCT [KANETSU SARETA SUIHEIKAN NAI NAGARE NO SUUCHI KAISEKI]** **c34**
Munekazu Mochizuki and Hiroshi Ishigaki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 205-209 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

The effects of buoyancy on fully developed laminar flow and heat transfer in a horizontal square duct are analyzed numerically. Thermal boundary conditions are axially constant wall heat flux and peripherally constant wall temperature. The results on friction factor, flow pattern, Nusselt number are discussed. Author (NASDA)

**N93-19306#** National Aerospace Lab., Kakuda (Japan).
**TURBULENCE MODEL CALCULATIONS OF THE EFFECTS OF BODY FORCES ON TURBULENT FLOWS IN A PIPE [NIJI NAGARE WO TOMONAU KANNAI RANRYUU NO KEISAN]** **c34**
Hiroshi Ishigaki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 211-215 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

The effects of centrifugal and Coriolis forces on fully developed turbulent flow in a curved or a orthogonally rotating pipe are studied numerically by using standard kappa-epsilon model of turbulence. Computational results are compared with the available experimental data on flow patterns, friction factors and heat transfer coefficients. Author (NASDA)

**N93-19307#** National Aerospace Lab., Kakuda (Japan). Research Center.
**COMPARATIVE STUDY OF VARIOUS DIFFERENCE SCHEMES FOR SOME LAMINAR CHANNEL FLOWS [KANNAIRYUU NO KEISAN NI OKERU SABUN SUKIMU NO HIKAKU]** **c34**
Hiroshi Tamura and Hiroshi Ishigaki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 217-220 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

Finite difference scheme (upwind, power and Quadratic Upstream Interpolation for Convective Kinematics (QUICK)) on the calculation of some laminar channel flows with body forces were examined. Computations were conducted for laminar flows in a square duct rotating around a perpendicular axis. Comparisons were made for some important results such as velocity distribution, secondary flow pattern and friction coefficient. The results indicated that the upwind scheme shows a large numerical diffusion but the power scheme gives reasonable results. Author (NASDA)

**N93-19308#** Tohoku Univ., Sendai (Japan). Dept. of Aeronautics and Space Engineering.

**NUMERICAL SIMULATIONS OF SUPERSONIC FLOW BY A FOURTH-ORDER COMPACT MUSCL TVD SCHEME [FOSU ODA KONPAKUTO MUSCL TVD SUKIMU NI YORU CHOUDNSOKU NAGARE NO SUUCHI SHIMYURESHON]**

Satoru Yamamoto and Hisaaki Daiguji *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 221-226 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A02/MF A03

A fourth order compact Monotonic Upstream Centered Schemes for Conservation Laws (MUSCL) Total Variation Diminishing (TVD) scheme is proposed for simulating supersonic inviscid and viscous flows. The fundamental form of the present scheme is based on the second (third) - order accurate MUSCL finite difference scheme. One of the distinctive points by using this scheme is to be able to capture weak discontinuities such as slip lines or contact surfaces as well as shocks more accurately than the existing TVD scheme. The algorithm is much simpler than the Essentially Non-Oscillatory (ENO) scheme. Therefore, they can be easily applied to any ordinary numerical solvers based on the second (third) - order MUSCL scheme. In order to verify the reliability of the present scheme, unsteady inviscid and viscous supersonic flows are computed. The results show that the slip line as well as oblique shocks can be captured completely. Author (NASDA)

**N93-19309#** National Aerospace Lab., Kakuda (Japan). Research Center.

**ANALYTICAL AND NUMERICAL STUDY ON STEADY MACH REFLECTION [MAHHA HANSHA KEIJOU KETTEI INSHI NI TSUITE]**

Takeshi Karita, Katsuhiro Itoh, and Kouichiro Tani *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 227-232 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A02/MF A03

It is not guaranteed for most of shock capturing schemes to obtain a physically relevant solution for complicated multi dimensional flow with shock wave reflection and crossing, such as steady Mach reflection. Ability of most of shock capturing schemes to simulate the steady Mach reflection has not been studied well because of the lack of solution for the steady Mach reflection in the large sense, i.e., not the solution for the vicinity of triple point, but for the whole Mach reflection flow region. In this paper, the analytical solution in the large sense is presented, and is used to study the ability of shock capturing scheme of the steady Mach reflection. Two inviscid flow simulations were made with the Harten-Yee type Total Variation Diminishing (TVD) scheme. The slip line configurations and the flows behind Mach stem by the scheme fairly agreed with the analytical ones, but the detailed flow structure, particularly around the triple point, did not agree well with the analytical solution. Author (NASDA)

**N93-19310#** Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).

**NUMERICAL SIMULATION OF THE FLOW THROUGH NON-UNIFORM AIRFOIL CASCADE [TAYOKUSO YOKURETSU MAWARI NO NAGARE NO SUUCHI SHIMYURESHON]**

Takashi Hokari, Shigeru Saito, Atsushige Tanaka, Hisao Takeuchi, Koji Matsunaga, Kazuo Kikuchi (National Aerospace Lab., Tokyo, Japan ), and Atsuhiro Tamura (National Aerospace Lab., Tokyo, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 233-237 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A01/MF A03

Numerical simulation for the cascade of aeroengine is usually done about circumferential same airfoils and is one pitch calculation. But in the real engine there are little changed airfoil or structures between cascade. So, one pitch calculation code was extended to multiple pitch and it was named as an analysis of nonuniform airfoil cascade. In this paper this code to bypass duct of a commercial jet engine was used and good agreement between analysis and experiment was obtained.

Author (NASDA)

**N93-19311#** Tokyo Univ. (Japan). Dept. of Aeronautics.

**NUMERICAL STUDY ON TRANSVERSE HYDROGEN INJECTION INTO A SUPERSONIC FLOWFIELD [CHOUONSOKURYUU CHUU HENO SUISO NO SUICHOKU FUKIDA SHI NI KANSURU KENKYUU]**

Kazuhiko Yokota and Shojiro Kaji *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 239-244 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A02/MF A03

A supersonic flow field with transverse sonic injection of hydrogen is calculated by using the two dimensional Reynolds time averaged full Navier-Stokes equations and q-omega turbulence model developed by Coakley. A Yee's type second order explicit symmetric Total Variation Diminishing (TVD) scheme is applied for spatial discretizations of convective terms of the equations. Wall pressure distribution of numerical results is compared with experimental data, and it is shown that the turbulence model is useful. In addition, the interactions between hydrogen injection and incident shock or expansion wave are simulated by the same procedure. The numerical results show that hydrogen distribution in the flow field becomes smaller by shock wave and larger by expansion wave slightly. When total temperature rises after an incident shock wave, which means a modeling of chemical reaction in flow, an interaction flow field with injection changes drastically. This suggests the importance of the similar study in chemically reacting flow. Author (NASDA)

**N93-19312#** Mitsubishi Electric Corp., Kamakura (Japan).

**AERODYNAMIC HEATING ANALYSIS FOR AXISYMMETRIC BODIES IN SUPERSONIC FLOW [CHOUONSOKU HISHOUTAI TOUBU KEIJOU MAWARI NO KUURIKI KANETSU KAISEKI]**

Masayuki Katayama, Ryujiro Kurosaki, Yoshiko Nakamura, Shigeru Aso (Kyushu Univ., Fukuoka, Japan ), and Kazuhiro Kumasaka (Mitsubishi Space Software Corp., Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 245-249 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A01/MF A03

Aerodynamic heating analyses have been performed for axisymmetric bodies in the supersonic flow. Both experiments using a shock tunnel and the computations corresponding to the experiments are conducted. Heat flux to the bodies such as a hemisphere cylinder and an ogive cylinder are measured. Flow conditions are: (1) Mach number M(sub infinity) = 4.25; (2) Reynolds numbers Re(sub infinity) = 2 to 3 x 10(exp 5), based on body radius; (3) stagnation temperatures T(sub 0) = 500 to 600 K; and (4) angle of attack alpha = 0 deg. Results of the experiments and the computations are summarized as follows. Heat flux to the hemisphere surface has the maximum value at the stagnation point and decreases smoothly downstream. Also the heat flux to the ogive surface is quite large in the vicinity of the tip and decreases gradually downstream in the case of fully laminar or fully turbulent flow. In the case of the flow including the transition, increase of heat flux caused by the transition of the boundary layer is observed. Lower and Upper - Alternating Direction Implicit (LU-ADI) difference scheme for compressible Navier-Stokes code has been used for the computations corresponding to the experiments. Computational results show good correlation to the experimental data obtained by the shock tunnel. Author (NASDA)

**N93-19313#** Kawasaki Heavy Industries Ltd., Gifu (Japan). Technical Inst.

**THREE DIMENSIONAL CALCULATION OF FLOW INSIDE SUPERSONIC INLET [CHOUONSOKU KUUKI TORIIREGUCHI NAI NO NAGARE NI TSUITE]**

Akira Fujimoto and Keisuke Sawada (Tohoku Univ., Sendai, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 251-255 In JAPANESE (For primary

document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

A three dimensional Navier-Stokes calculation of flow inside a supersonic mixed compression inlet, designed for Mach 2.5, was carried out. A multiblock method was applied to the calculation grids. Complex configurations of bleed holes and throat slot were simulated in order to compare the solution with experimental data. As a result, detail information of the flow, which was usually difficult to obtain in an experiment, was obtained. On this inlet under the supersonic flow through conditions, the flow was found to be two dimensional in 0 percent of spanwise direction. In the vicinity of the sidewalls, however, three dimensional separation occurred along the cowl shock. The separation induced a vortex, and the vortex was stretched and swallowed into the throat slot. The ramp bleed ahead of the cowl shock impinge line was found to play an important role for avoiding the separation region to spread. A static wall pressure comparison between the results and the experimental data showed reasonable agreement.

Author (NASDA)

**N93-19314#** Nissan Motor Co. Ltd., Tokyo (Japan).
**NUMERICAL SIMULATION OF FLOWS IN A SUPERSONIC AIR INTAKE [CHOUONSOKU EAINTEKU NI OKERU NAGARE NO SUUCHI KAISEKI]**
Naoki Tamura, Nobuhiro Sekino, Naohisa Tujimura, Toru Shimada, and Kazuyuki Hirasawa (Nissan Aerospace Engineering Co., Ltd., Tokyo, Japan) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 257-262 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Numerical solutions of Reynolds averaged Navier-Stokes equations are obtained for two dimensional flows inside a mixed compression supersonic air intake with its operation range from supercritical to subcritical. Computed wall pressure data are compared with wind tunnel data to show that their agreement is quite good except for the secondary postshock value, although the analytical value agrees quite well with the present computation. This discrepancy may be due to a three dimensional effect in the wind tunnel experiment. A comparison among numerical solutions for an inviscid flow obtained by the use of several types of numerical flux expressions indicates that solutions are strongly affected by the flux scheme and a possible reason for this can be attributed to the scheme's capability of resolving linear characteristic waves. Author (NASDA)

**N93-19315#** Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
**A NUMERICAL INVESTIGATION FOR SUPERSONIC INLET [CHOUONSOKU INTEKU NAI NAGARE NO SUUCHI SHIMYURESHON]**
Junji Shigematsu, Kazuo Shiraishi, Atsushige Tanaka, and Kazuomi Yamamoto (National Aerospace Lab., Tokyo, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 263-270 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

The flow field in high efficiency mixed compression inlet with throat cavity have been performed numerically by solving two dimensional compressible Navier-Stokes equations using Harten-Yee's Total Variation Diminishing (TVD) scheme. In the present study, the configuration of the experimental inlet is taken in computation as closely as possible. The flow field of the inlet including the throat cavity region is discretized and solved simultaneously with the external flow regions. The numerical results demonstrate the flow behaviors around the throat cavity for typical cases of the mass flow plug and wall bleed. Comparison with the experimental results for static pressure distributions and flow characteristics shows reasonable agreements and also detects the limitation of the two dimensional analysis. Author (NASDA)

**N93-19316#** Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
**A NUMERICAL INVESTIGATION OF 3D TRANSVERSE INJECTION INTO THE SUPERSONIC FLOW BEHIND REARWARD FACING STEP [USHIRO MUKI SUTEPPU KOUHOU KARA NO CHOUONSOKU CHUU HENO SUICHOKU FUNSHA NO SUUCHI KAISEKI]**
Toshiro Fujimori (Kyushu Univ., Fukuoka, Japan ), Yasunori Ando (Kyushu Univ., Fukuoka, Japan ), Masafumi Kawai (Kyushu Univ., Fukuoka, Japan ), Yasunori Ohmori (Kyushu Univ., Fukuoka, Japan ), and Masahiro Fukuda (National Aerospace Lab., Tokyo, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 271-276 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Three dimensional Reynolds averaged full Navier-Stokes equation including chemical reactions solver is developed to predict flow fields in scramjet engine combustors. Using the above code, sonic gas transverse injections behind the rearward facing step into the M = 3.7 supersonic flow are investigated numerically. The numerical results are compared with the result of the transverse injection on the flat plate. The comparison shows that mixing of injectant gas with main air flow is enhanced by the rearward facing step. Author (NASDA)

**N93-19317#** Mitsubishi Heavy Industries Ltd., Tokyo (Japan).
**NUMERICAL CALCULATION OF FLOW FIELD IN SUPERSONIC COMBUSTION CHAMBER [CHOUONSOKU NENSHOUKI NAI NAGARE NO SUUCHI KAISEKI]**
Makoto Nishiuchi *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 277-282 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

There has been a renewed interest in hypersonic air breathing propulsion during the last decade. This interest is mainly associated with the study of hypersonic flight vehicles and space planes. A major focus of these studies is to develop new concept in propulsion technology. One of the propulsion concepts is based on supersonic combustion ramjet (Scramjet). However, because of the difficulties in experimentally simulating the actual flight environment, the details of the flow phenomena in the scramjet combustor, in particular the physics and fluid mechanism of the supersonic combustion process, are not well understood. Fortunately the recent progress of supercomputers and the advanced numerical algorithms have made it possible to analyze the combustor flow field with turbulence models and finite rate chemical reactions. In the present study, a numerical algorithm for supersonic flow with hydrogen and air combustion was developed, and two test cases were computed. These results are compared with existing available computational and experimental results. Author (NASDA)

**N93-19318#** Fuji Heavy Industries Ltd., Utsunomiya (Japan).
**A NUMERICAL SIMULATIONS OF INNER FLOW OF SCRAMJET [SUKURAMUJETTO NAI RYUU NO SUUCHI SHIMYURESHON]**
Hiroshi Wakai *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 283-288 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

The flow fields over interior and exterior of simplified scramjet model are simulated numerically by two dimensional Navier-Stokes equations using an implicit finite difference scheme. For these simulations, the numerical scheme based on Chakravarthy Osher's Total Variation Diminishing (TVD) formulation is improved for multigrid application and Simple & Robust wall boundary conditions are applied. In this paper, the computed results are compared with two kinds of experiments, one is conducted by high speed wind tunnel and the other is conducted by hydraulic tank.

Author (NASDA)

**N93-19319#** Tokyo Univ. (Japan).
**THREE-DIMENSIONAL MEASUREMENT OF TURBULENT SHEAR FLOWS USING DIGITAL IMAGE PROCESSING [DEJITARU GAZOU SHORI NI YORU SENDAN RANYUU NO SANJIGEN KEISOKU]** **c34**
Nobuhide Kasagi and Koichi Nishino (Yokohama National Univ., Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 289-295 In JAPANESE Sponsored by Ministry of Education and Mitsubishi Foundation (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

A three Dimensional Particle Tracking Velocimeter (3-D PTV) for the measurement of turbulent shear flows is described with emphasis on its instrumentation, experimental procedure and data processing algorithm. Motions of neutrally buoyant tracer particles (Nylon 12, specific density of 1.02, typical diameter of 200 micrometer) suspended in a water flow are tracked with a highly automated digital image processing system. Local fluid velocities are determined from 3-D displacement of each particle and

the time interval over which particles are tracked. This technique is advantageous over existing one point measuring techniques such as hot-wire and film probes and a laser Doppler velocimeter in that it can provide not only one point turbulence statistics but also spatial information on the turbulence structures. Such a feature is particularly desirable for the study of coherent turbulence structures which are considered to play a dominant roll in turbulence mechanism. Typical results obtained by the 3-D PTV in fundamental turbulent flows are presented to demonstrate practical capability of the technique. Some perspectives on future research direction of the 3-D PTV are also presented. Author (NASDA)

**N93-19320#** National Aerospace Lab., Tokyo (Japan).
**WIND TUNNEL WALL INTERFERENCE CORRECTION AT SUBSONIC SPEEDS [AONSOKU NAGARE NI OKERU FUUDOUHEKI KANSHOU SHUUSEI]**
Hideo Sawada *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 297-303 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

In the wall interference correction of the wind tunnel tests, the fundamental equation of the flow field must be linear everywhere inside the test section. However, the estimated wall interference corrections are often reasonable even in nonlinear cases. Some test results obtained at the NAL's two dimensional wind tunnel show the correction method is available even in the flow of Mach number 0.8. Available mathematical models for the ventilated wall characteristics are not accurate enough for the wall interference estimation. So, it is better to use the pressure distributions on the wind tunnel walls in place of the mathematical model to estimate the ventilated wall interference. This method is available in case of estimating the two dimensional wall interference. It is difficult to measure reliable pressure distributions over the four wall planes of the test section. So, the method has not been available in case of estimating the three dimensional wall interference. In principle, test sections with the adaptive walls will be solved the wall interference problem even in the transonic flow. More than 20 two dimensional test sections with the adaptive walls have been in use in the world. Author (NASDA)

**N93-19321#** National Aerospace Lab., Tokyo (Japan).
**TWO PROBLEMS REDUCING THE DATA ACCURACY IN TRANSONIC WIND TUNNEL TESTING [FUUDOU SHIKEN NI OKERU 2, 3 NO MONDAI NI TSUITE: SENONSOKU DENO SHIKEN SEIDO WO SOGAI SURU YOUIN]**
Iwao Kawamoto *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 305-311 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

Two problems concerning the data accuracy in transonic wind tunnel testing are described. One is the side wall boundary layer interference problem in the airfoil testing. In the transonic airfoil testing, it is believed that the side wall B.L. suction brings the improvement of the two-dimensionality of the airfoil surface flow. But it is not so simple. In NAL 2D high Reynolds number transonic wind tunnel, the measurements of side wall boundary layer thickness, Mach number distribution along center line and pressure distribution on NACA0012 airfoil were conducted with and without side wall boundary layer suction through a pair of rigimeshes. Following conclusions are derived in the present experimental studies. The B.L. suction system was not useful for the improvement of the airfoil surface flow, then theoretical side wall boundary layer correction such as Barnwell and Murthy methods should be employed to the data used solid side walls at the present time. Another problem presented here is transition Reynolds number of the experimental model. Using the AEDC standard cone, transition Reynolds number in several large transonic wind tunnels including NAL2m x 2mTWT are compared with flight data emphasizing the effects of back ground noise Cprms. Present comparative study shows that at low Mach number region Cprms does not promote the transition point forward and at high Mach number region the transition point is moved forward with large Cprms. Author (NASDA)

**N93-19322#** National Aerospace Lab., Tokyo (Japan).
**ON THE ROLES OF WIND TUNNEL TESTING AND COMPUTATIONAL FLUID DYNAMICS IN THE AIRCRAFT DEVELOPMENT [KOUKUUKI KAIHATSU NI OKERU FUUDOU SHIKEN TO CFD]** **c05**
Susumu Takanashi *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 313-318 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

In this paper, the roles of wind tunnel testing and Computational Fluid Dynamics (CFD) in the aircraft development is briefly described. The stress is put on the importance of CFD as an aerodynamic design tool to drastically reduce both cost and period of development. Prior to the application of CFD to practical design problems, the existing CFD codes must be verified with the reliable experimental data. A demonstrative example of CFD validation is presented to show the state of the arts of CFD by comparing the Navier-Stokes simulation results with the transonic wind tunnel test data for a NACA0012 airfoil at several angles of attack. The importance of application of CFD to inverse design problem is also discussed.
Author (NASDA)

**N93-19323#** Fuji Heavy Industries Ltd., Utsunomiya (Japan). Aircraft Factory.
**WIND TUNNEL TESTS AND CFD IN FUJI HEAVY INDUSTRIES [FUJI JUUKOUGYOU NI OKERU FUUDOU SHIKEN TO CFD]**
Kohei Tanaka, Hidehiro Hirose, and Yasuhiro Koshioka *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 319-326 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

With the evolution of the Computational Fluid Dynamics (CFD) technology, the role of wind tunnel has come to be reevaluated. In this paper, the impact of CFD validation with wind tunnel is discussed, that is going to bring the needs for high accuracy of test data, and that will finally lead to more accurate new test technique, e.g., magnetic suspension, free from the mount interference or high Reynolds Number (RN) lowspeed wind tunnel, actually very useful for the low risk aircraft development. Also, wind tunnel facilities in Fuji Heavy Industries, Ltd. (FHI) Aerospace Division are introduced. With CFD technology and test technology, FHI has capability of wide range class airframe development; from lowspeed small target plane to space reentry vehicle. Author (NASDA)

**N93-19324#** Kawasaki Heavy Industries Ltd., Gifu (Japan). Aircraft Research Lab.
**WIND TUNNEL TEST AND CFD IN KAWASAKI HEAVY INDUSTRIES, GIFU [KAWASAKI JUUKOUGYOU GIFU NI OKERU FUUDOU SHIKEN TO CFD]**
Kenji Sakai *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 327-332 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

In Kawasaki Gifu, the wind tunnel tests and Computational Fluid Dynamics (CFD) technologies have been mostly developed since the beginning of 1970. Three dimensional transonic wind tunnel test with 1 m x 1 m test section and three dimensional Navier-Stokes analysis are now available in the design work for many airplanes and aerospace vehicles. For example, some airplanes (STOL, T-4 etc.) and helicopters (BK117 etc.) were developed by using these useful technologies. This report presents the current status of these technologies in Kawasaki Gifu and the future roles respectively.
Author (NASDA)

**N93-19325#** Mitsubishi Heavy Industries Ltd., Nagoya (Japan). Aerospace Systems.
**WIND TUNNEL TESTING AND CFD SIMULATION IN MITSUBISHI HEAVY INDUSTRIES [MITSUBISHI JUUKOUGYOU NI OKERU FUUDOU SHIKEN TO CFD]**
Hideki Nomoto and Junichi Miyakawa *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 333-336 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

Computational Fluid Dynamics (CFD) has established its unique position as a design tool in aerospace industries. As the CFD technology has evolved, the relationship with the conventional design tool of wind tunnel testing has also changed accordingly. This paper reviews the relationship of the two major technologies in Mitsubishi Nagoya. The typical CFD application are briefly introduced during the discussion. Author (NASDA)

**N93-19326#** Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).

**ROLE OF WIND TUNNEL TESTS AND CFD ANALYSIS FOR THE DEVELOPMENT OF AERO-ENGINES IN IHI [IHI KOUKUU ENJIN NI OKERU FUUDOU JIKKEN TO CFD]** **c07**

Atsushige Tanaka *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 337-344 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

When aeroengines are developed, several different types of wind tunnel tests are involved. For instance, one type of tunnel is required for fundamental tests of the cascades; a second is required for high altitude engine performance tests. Experimental models for these tests consist of real engine components or of close replicas. Certain effects may not be adequately addressed in wind tunnel tests, for example, the effects of high speed revolution, flow properties in unmeasurable regions, realistic boundary conditions. The twofold object of Computational Fluid Dynamics (CFD) for internal flows is to predict the performance of models before expensive wind tunnel tests are done and to provide information of the internal flow that is inaccessible to experiment measurement. CFD is already useful for improving designs or making new ones. As computers and CFD technology advance, CFD can expand from the role of prediction and design to that of a numerical wind tunnel. This paper shows how features of numerical wind tunnels parallel those of experimental wind tunnels. The paper also assesses future trends for the use of numerical wind tunnels.

Author (NASDA)

**N93-19340#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**EXPERIMENTAL INVESTIGATION OF THE AERODYNAMICS OF INDEPENDENTLY ROTATING CYLINDRICAL SHELLS M.S. Thesis**

Walter C. Howerton Dec. 1992 91 p
(AD-A258917; AFIT/GAE/ENY/92D-11) Avail: CASI HC A05/MF A01

The purpose of this thesis was to investigate experimentally the aerodynamic forces on two adjacent, independently rotating cylinders in a cross-flow. This investigation involved a force measurement setup which had the two cylinders mounted on a common support shaft, extending beyond the span of the wind tunnel test section, and supported by spoke rings with strain gages in the vertical and horizontal directions. This setup proved capable of measuring aerodynamic forces. The lift on the independently rotating cylinders was found to increase as one cylinder's angular speed increased while the other's remained constant, and decrease as the relative angular rate decreased. The drag coefficient was fairly constant over the range of velocity ratios tested, and minimal changes were noted with relative changes in angular speeds. Interactions between the two cylinders had the most effect on the lift and drag above 40 percent disparity in the angular rotation rates. The investigation also showed that for an offset angle of 30 deg on an approximately two-dimensional cylinder, the normal component of freestream velocity may be treated as the only significant contributor to the forces on the cylinder. GRA

**N93-19364#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**APPLICATION OF THE PROGRAM PROFILE FOR THE DESIGN OF LOW-SPEED, LOW-OBSERVABLE CONFIGURATION AIRFOILS M.S. Thesis**

Gregory A. Sharp Dec. 1992 216 p
(AD-A258842; AFIT/ENY/GAE/92D-09) Avail: CASI HC A10/MF A03

The use of the program PROFILE for the design of low-speed, low-observable configuration airfoils was investigated. For our purposes, low-observable configuration is defined as being characterized by a small leading-edge radius of less than 1.18 percent chord and a thickness-to-chord ratio of 2.5 to 5.5 percent. A methodology was developed whereby the input parameters to prescribe the velocity distribution over the airfoil could be determined by a power law relationship. This relationship enables the designer to develop symmetric airfoils with the desired thickness-to-chord and leading-edge radius within the stated constraints. The resulting symmetric airfoils compared very well with NACA 4-digit airfoils of like thickness-to-chord ratio. The resulting airfoils have an increased stall angle compared to the NACA 4-digit airfoils. GRA

**N93-19379*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**ISSUES AND APPROACH TO DEVELOP VALIDATED ANALYSIS TOOLS FOR HYPERSONIC FLOWS: ONE PERSPECTIVE**

George S. Deiwert Oct. 1992 21 p
(RTOP 506-40-41)
(NASA-TM-103937; A-92094; NAS 1.15:103937) Avail: CASI HC A03/MF A01

Critical issues concerning the modeling of low-density hypervelocity flows where thermochemical nonequilibrium effects are pronounced are discussed. Emphasis is on the development of validated analysis tools. A description of the activity in the Ames Research Center's Aerothermodynamics Branch is also given. Inherent in the process is a strong synergism between ground test and real-gas computational fluid dynamics (CFD). Approaches to develop and/or enhance phenomenological models and incorporate them into computational flow-field simulation codes are discussed. These models have been partially validated with experimental data for flows where the gas temperature is raised (compressive flows). Expanding flows, where temperatures drop, however, exhibit somewhat different behavior. Experimental data for these expanding flow conditions are sparse; reliance must be made on intuition and guidance from computational chemistry to model transport processes under these conditions. Ground-based experimental studies used to provide necessary data for model development and validation are described. Included are the performance characteristics of high-enthalpy flow facilities, such as shock tubes and ballistic ranges. Author

**N93-18086*#** Eloret Corp., Sunnyvale, CA.

**INCREASE OF STAGNATION PRESSURE AND ENTHALPY IN SHOCK TUNNELS**

David W. Bogdanoff and Jean-Luc Cambier *In its* Experimental Investigation of Nozzle/Plume Aerodynamics at Hypersonic Speeds 3 Dec. 1992 46 p (For primary document see N93-18085 06-20)
(Contract NCC2-487)
Avail: CASI HC A03/MF A02

**N93-19003#** Technische Univ., Delft (Netherlands).

**PROPELLING FORCE AND RESISTANCE [STUWKRACHT EN WEERSTAND]**

W. B. deWolf *In its* Professor Wittenberg: His Speciality and Versatility 1991 p 9-27 In DUTCH (For primary document see N93-19002 06-01)
Copyright Avail: CASI HC A03/MF A01

**N93-19006#** Technische Univ., Delft (Netherlands).

**WHAT IS THE PROGRESS IN PROPULSION? [ZIT ER VAART IN VOORTSTUWING?]**

P. A. O. G. Korting *In its* Professor Wittenberg: His Speciality and Versatility 1991 p 59-80 In DUTCH (For primary document see N93-19002 06-01)
Copyright Avail: CASI HC A03/MF A01

**N93-19921#** Industrie Aeronautiche e Meccaniche Rinaldo Piaggio S.p.A., Genoa (Italy).

**NATURAL LAMINAR FLOW TEST IN-FLIGHT VISUALIZATION**

G. Sacco, P. Cinquetti, and S. Martini *In* AGARD, Flight Testing Oct. 1992 8 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A02/MF A04

**N93-19922#** Calspan Corp., Arnold AFS, TN. Arnold Engineering Devlopment Center.

**A TECHNIQUE FOR PREDICTING AIRCRAFT FLOW-FIELD EFFECTS UPON AN UNGUIDED BOMB BALLISTIC TRAJECTORY AND COMPARISON WITH FLIGHT TEST RESULTS**

H. Paschall Massengill, Jr. *In* AGARD, Flight Testing Oct. 1992 12 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

# 03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

**N93-18031#** Computer Resource Management, Inc., Herndon, VA.
**NATIONAL AIRSPACE SYSTEM FLIGHT PLANNING OPERATIONAL CONCEPT NAS-SR-131**
William Trent, Thomas Pickerell, and Harold Nelson, Jr. Sep. 1992 55 p
(Contract DTFA01-91-Y-01004)
(DOT/FAA/SE-92/4) Avail: CASI HC A04/MF A01

This document is an operational concept of the flight planning processing system which will be in place upon implementation of the Federal Aviation Administration (FAA) National Airspace System (NAS) Plan. Flight planning encompasses all activities involved in the preparation of a flight, including the information retrieved by the pilot prior to the flight and used to make go/no go decisions; the information conveyed by the pilot to the NAS in the form of a flight plan; and all NAS-related services which support these activities. The objective of this document is to describe the relationship between subsystems, facilities, information, and operators/users involved in the flight planning process. In addition, the elements and operations of the NAS Plan are mapped into the flight planning requirements stated in the National Airspace System Requirement Specification (NASSRS, NASSR-1000). Several types of block diagrams are used to illustrate systems connectivity and operational flow. Scenarios are also derived to describe the flight planning process from a user's perspective. This concept along with seven other operational concepts will complete the description of the system requirements as described in the NASSRS. The eight operational concepts are: communications, navigation, monitoring, maintenance and support, system effectiveness, air defense, flight planning, and traffic control and airspace management. Author

**N93-18036#** Wichita State Univ., KS. National Inst. for Aviation Research.
**THE AIRLINE QUALITY REPORT, 1992**
Brent D. Bowen and Dean E. Headley Mar. 1992 34 p
(NIAR-92-11) Avail: CASI HC A03/MF A01

The Airline Quality Rating 1992 is a summary of month-by-month quality ratings for major domestic U.S. airlines operating during 1991. Using the Airline Quality Rating (AQR) system and performance data for each airline for the calendar year of 1991, ratings and rankings are reported. The Airline Quality Rating was developed and announced in early 1991 as an objective method of comparing airline performance on multiple factors important to consumers. Compiled industry results that yield average rankings for all airlines are included in this Airline Quality Report 1992. The AQR rating system is detailed in NIAR Report 91-11, The Airline Quality Rating, issued in April, 1991, by the National Institute for Aviation Research at The Wichita State University. This current research monograph, NIAR Report 92-11 contains a brief summary of the AQR methodology, comments and strategic observations about the airline industry that grow from analysis of the ratings and from the authors perceptions regarding industry trends and events over the past years, and detailed data and charts that track comparative quality for major domestic airlines across the 12 month period. Author

**N93-19590*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS: FOURTH COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 1**
Dan D. Vicroy, comp., Roland L. Bowles, comp., and Robert H. Passman, comp. (Federal Aviation Administration, Washington, DC.) Sep. 1992 597 p Conference held in Williamsburg, VA, 14-16 Apr. 1992; sponsored by NASA and FAA Original contains color illustrations
(RTOP 505-64-12-01)
(NASA-CP-10105-Pt-1; NAS 1.55:10105-Pt-1; DOT/FAA/RD-92/19-I-Pt-1)
Avail: CASI HC A25/MF A06; 28 functional color pages

The purpose of the meeting was to transfer significant ongoing results of the NASA/FAA joint Airborne Wind Shear Program to the technical industry and to pose problems of current concern to the combined group. It also provided a forum for manufacturers to review forward-look technology concepts and for technologists to gain an understanding of the problems encountered by the manufacturers during the development of airborne equipment and the FAA certification requirements. The present document was compiled to record the essence of the technology updates and discussions which follow each. For individual titles, see N93-19591 through N93-19612.

**N93-19591*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**PROGRAM OVERVIEW: 1991 FLIGHT TEST OBJECTIVES**
Roland L. Bowles *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 7-22 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: the Joint NASA/FAA Airborne Wind Shear Detection and Avoidance Program; the windshear problem; NASA/FAA Wind Shear Program objectives; program elements; Wind Shear Program roadmap; airborne wind shear sensors; 1991 wind shear flight experiments; operative wind shear detection systems; research aircraft sensor installations; and 1991 test results. Author

**N93-19592*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**FLIGHT TEST OPERATIONS**
Michael S. Lewis *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 23-43 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

Flight test operations concerning the Joint NASA/FAA Airborne Wind Shear Detection and Avoidance Program 1991 Flight Experiments are presented in viewgraph form and include the following: research aircraft sensor installations; wind shear reactive sensor operation; wind shear IR sensor operation; wind shear radar sensor operation; wind shear lidar sensor operation; and 1991 flight test summary. Author

**N93-19593*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**NASA WIND SHEAR FLIGHT TEST IN SITU RESULTS**
Rosa M. Oseguera *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 45-58 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

The main objectives in developing the NASA in situ windshear detection algorithm were to provide a measurement standard for validation of forward-look sensors under development, and to demonstrate the algorithm's ability to operate with a suitably low nuisance alert rate. It was necessary to know exactly how the algorithm was implemented and what parameters and filtering were used, in order to be able to fully test its effectiveness and correlate in situ results with forward-look sensor data. Author

**N93-19594*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AIR/GROUND WIND SHEAR INFORMATION INTEGRATION: FLIGHT TEST RESULTS**
David A. Hinton *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 59-114 Original contains color illustrations (For primary document see N93-19590 06-03)
Avail: CASI HC A04/MF A06; 28 functional color pages

An element of the NASA/FAA wind shear program is the integration of ground-based microburst information on the flight deck, to support airborne wind shear alerting and microburst avoidance. NASA conducted a wind shear flight test program in the summer of 1991 during which airborne processing of Terminal Doppler Weather Radar (TDWR) data was used to derive microburst alerts. High level microburst products were extracted from TDWR, transmitted to a NASA Boeing 737 in flight via data link, and processed to estimate the wind shear hazard level (F-factor) that would be

experienced by the aircraft in the core of each microburst. The microburst location and F-factor were used to derive a situation display and alerts. The situation display was successfully used to maneuver the aircraft for microburst penetrations, during which in situ 'truth' measurements were made. A total of 19 penetrations were made of TDWR-reported microburst locations, resulting in 18 airborne microburst alerts from the TDWR data and two microburst alerts from the airborne in situ measurements. The primary factors affecting alerting performance were spatial offset of the flight path from the region of strongest shear, differences in TDWR measurement altitude and airplane penetration altitude, and variations in microburst outflow profiles. Predicted and measured F-factors agreed well in penetrations near microburst cores. Although improvements in airborne and ground processing of the TDWR measurement would be required to support an airborne executive-level alerting protocol, the feasibility of airborne utilization of TDWR data link data has been demonstrated. Author

**N93-19595*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**DOPPLER RADAR RESULTS**

Emedio M. Bracalente *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 115-140 Original contains color illustrations (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are covered in viewgraph form and include the following: (1) a summary of radar flight data collected; (2) a video of combined aft cockpit, nose camera, and radar hazard displays; (3) a comparison of airborne radar F-factor measurements with in situ and Terminal Doppler Weather Radar (TDWR) F-factors for some sample events; and (4) a summary of wind shear detection performance. Author

**N93-19596*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**FLIGHT TEST OF AN INFRARED WIND SHEAR DETECTOR**

Burnell T. McKissick *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 141-192 (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: 5 microburst core penetrations; Airborne Warning and Avoidance System 3 (AWAS 3) overall performance; and issues of concern. Author

**N93-19597*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**WIND SHEAR HAZARD DETERMINATION**

Michael S. Lewis *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 195-211 (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: F-factor relationship with aircraft performance; F-factor formulations; the F-bar index; F-factor hazard limit; F-bar with Doppler sensors; and F-bar profile composite. Author

**N93-19598*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**THREE-DIMENSIONAL NUMERICAL SIMULATION OF THE 20 JUNE 1991, ORLANDO MICROBURST**

Fred H. Proctor *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 213-243 Original contains color illustrations (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

On 20 June 1991, NASA's Boeing 737, equipped with in-situ and look-ahead wind-shear detection systems, made direct low-level penetrations (300-350 m AGL) through a microburst during several stages of its evolution. This microburst was located roughly 20 km northeast of Orlando International Airport and was monitored by a Terminal Doppler Weather Radar (TDWR) located about 10 km south of the airport. The first NASA encounter with this microburst (Event 142), at approximately 2041 UTC, was during its intensification phase. At flight level, in-situ measurements indicated a peak 1-km (averaged) F-factor of approximately 0.1. The second NASA encounter (Event 143) occurred at approximately 2046 UTC, about the time of microburst peak intensity. It was during this penetration that a peak 1-km F-factor of approximately 17 was encountered, which was the largest in-situ measurement of the 1991 summer deployment. By the third encounter (Event 144), at approximately 2051 UTC, the microburst had expanded into a macroburst. During this phase of evolution, an in-situ 1-km F-factor of 0.08 was measured. The focus of this paper is to examine this microburst via numerical simulation from an unsteady, three-dimensional meteorological cloud model. The simulated high-resolution data fields of wind, temperature, radar reflectivity factor, and precipitation are closely examined so as to derive information not readily available from 'observations' and to enhance our understanding of the actual event. Characteristics of the simulated microburst evolution are compared with TDWR and in-situ measurements. Author

**N93-19599*#** Oklahoma Univ., Oklahoma City. Sarkeys Energy Center.

**A NUMERICAL FIELD EXPERIMENT APPROACH FOR DETERMINING PROBABILITIES OF MICROBURST INTENSITY**

Kelvin K. Droegemeier and Terry Zweifel (Honeywell, Inc., Phoenix, AZ.) *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 245-283 (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

Several investigators had determined that some atmospheric parameters were related to the formation and severity of microbursts. For example, Caracena pointed out the relationship between a dry adiabatic lapse rate and microbursts in 'The crash of Delta Flight 191 at Dallas-Fort Worth international airport'. These early investigations led to the idea that numeric modeling of microbursts with varying atmospheric parameters might define 'signatures' that could lead to determining the probability of microburst intensity. The idea was that, by using already available sensors (such as static air temperature, pressure altitude, and radar reflectivity) onboard an aircraft, a reliable prediction of microburst existence and intensity could be formed. Such data could be used to create an 'expert meteorologist' using either artificial intelligence or other techniques that could be used in either reactive or look-ahead systems to vary sensitivity thresholds and coordinate the inputs from different detecting systems. To this end, Honeywell contracted to have the microburst simulations run. The questions to be addressed were the following: using the sensor set available to the aircraft (e.g. temperature, radar reflectivity, etc.), can we calculate the probability that (1) a microburst could be formed? and (2) that the resultant winds would be of sufficient magnitude to threaten the aircraft? Over a two year period, a data set of 1800 microburst simulations was accumulated. Verification of the microburst simulation was obtained using the results of other independent researchers and actual comparison to microburst events in Orlando and Denver. Some of the results from the simulation have already been incorporated into Honeywell's Windshear Detection and Guidance System with excellent results. Various aspects of this investigation are presented in viewgraph form. Author

**N93-19600*#** Martin Marietta Aerospace, Washington, DC. Air Traffic Systems.

**AN APPROACH TO EVALUATING REACTIVE AIRBORNE WIND SHEAR SYSTEMS**

Joseph P. Gibson, Jr. *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 287-301 (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

An approach to evaluating reactive airborne windshear detection systems was developed to support a deployment study for future FAA ground-based windshear detection systems. The deployment study methodology assesses potential future safety enhancements beyond planned capabilities. The reactive airborne systems will be an integral part of planned windshear safety enhancements. The approach to evaluating reactive airborne systems involves separate analyses for both landing and take-off scenario. The analysis estimates the probability of effective warning considering several factors including NASA energy height loss characteristics, reactive alert timing, and a probability distribution for microburst strength. Author

**N93-19601*#** Allied-Signal Aerospace Co., Fort Lauderdale, FL.
**RDR-4B DOPPLER WEATHER RADAR WITH FORWARD LOOKING WIND SHEAR DETECTION CAPABILITY**
Steven S. Grasley *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 317-338 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: Bendix/King atmospheric transport and dispersion (ATAD) position; RDR-4A technical baseline; RTA-4A characteristics; RDR-4 antenna characteristics; modification of RDR-4A to RDR-4B; RDR-4A functional block diagram; RDR-4B characteristics; development/test plan; CV-580 testing capability; CV-580 test results; Continental A300 test configuration; Continental Data Recording Program operational considerations; Continental A300 test results; and display considerations. Author

**N93-19602*#** Rockwell International Corp., Cedar Rapids, IA. Air Transport Div.
**AIRBORNE DOPPLER RADAR RESEARCH AT ROCKWELL INTERNATIONAL**
Roy E. Robertson *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 339-371 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following: the Collins 1991 Windshear Flight Program; and system considerations. Author

**N93-19603*#** Westinghouse Electric Corp., Baltimore, MD. Electronic Systems Group.
**ACQUISITION AND USE OF ORLANDO, FLORIDA AND CONTINENTAL AIRBUS RADAR FLIGHT TEST DATA**
Michael C. Eide and Bruce Mathews *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 373-388 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

Westinghouse is developing a lookdown pulse Doppler radar for production as the sensor and processor of a forward looking hazardous windshear detection and avoidance system. A data collection prototype of that product was ready for flight testing in Orlando to encounter low level windshear in corroboration with the FAA-Terminal Doppler Weather Radar (TDWR). Airborne real-time processing and display of the hazard factor were demonstrated with TDWR facilitated intercepts and penetrations of over 80 microbursts in a three day period, including microbursts with hazard factors in excess of .16 (with 500 ft. PIREP altitude loss) and the hazard factor display at 6 n.mi. of a visually transparent ('dry') microburst with TDWR corroborated outflow reflectivities of +5 dBz. Range gated Doppler spectrum data was recorded for subsequent development and refinement of hazard factor detection and urban clutter rejection algorithms. Following Orlando, the data collection radar was supplemental type certified for in revenue service on a Continental Airlines Airbus in an automatic and non-interferring basis with its ARINC 708 radar to allow Westinghouse to confirm its understanding of commercial aircraft installation, interface realities, and urban airport clutter. A number of software upgrades, all of which were verified at the Receiver-Transmitter-Processor (RTP) hardware bench with Orlando microburst data to produce desired advanced warning hazard factor detection, included some preliminary loads with automatic (sliding window average hazard factor) detection and annunciation recording. The current (14-APR-92) configured software is free from false and/or nuisance alerts (CAUTIONS, WARNINGS, etc.) for all take-off and landing approaches, under 2500 ft. altitude to weight-on-wheels, into all encountered airports, including Newark (NJ), LAX, Denver, Houston, Cleveland, etc. Using the Orlando data collected on hazardous microbursts, Westinghouse has developed a lookdown pulse Doppler radar product with signal and data processing algorithms which detect realistic microburst hazards and has demonstrated those algorithms produce no false alerts (or nuisance alerts) in urban airport ground moving vehicle (GMTI) and/or clutter environments. Author

**N93-19604*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**VERTICAL WIND ESTIMATION FROM HORIZONTAL WIND MEASUREMENTS**
Dan D. Vicroy *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 391-416 Original contains color illustrations (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

This presentation begins with a brief description of the downdraft measurement problem for airborne Doppler based systems and the importance of the downdraft in assessing the hazard posed by a microburst wind shear. This is followed by a review of research on the feasibility of using simple microburst models to compute the downdraft from horizontal wind measurements. The current methodologies for computing the vertical wind are then discussed. A summary of the results and the plan for future research are also presented. Author

**N93-19605*#** Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.
**MICROBURST CHARACTERISTICS DETERMINED FROM 1988-1991 TDWR TESTBED MEASUREMENTS**
Paul J. Biron and Mark A. Isaminger *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 417-455 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

This paper presents some recent results germane to airborne windshear system design and certification. We first discuss the data analysis procedure and the associated caveats. The relative frequency, severity, and duration of microburst hazards at the various locations is important for determining the tradeoffs between safety and operational impact of false alerts which are encompassed in detection system thresholds. We then consider radar/lidar design issues such as reflective in microbursts and the vertical structure of outflows. Finally, we provide recent surface thermodynamic data associated with microbursts. Author

**N93-19606*#** Honeywell, Inc., Minneapolis, MN. Systems and Research Center.
**ALGORITHMS FOR AIRBORNE DOPPLER RADAR WIND SHEAR DETECTION**
Jeff Gillberg, Mitch Pockrandt, Peter Symosek, and Earl T. Benser *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 457-473 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

Honeywell has developed algorithms for the detection of wind shear/microburst using airborne Doppler radar. The Honeywell algorithms use three dimensional pattern recognition techniques and the selection of an associated scanning pattern forward of the aircraft. This 'volumetric scan' approach acquires reflectivity, velocity, and spectral width from a three dimensional volume as opposed to the conventional use of a two dimensional azimuthal slice of data at a fixed elevation. The algorithm approach is based on detection and classification of velocity patterns which are indicative of microburst phenomenon while minimizing the false alarms due to ground clutter return. Simulation studies of microburst phenomenon and x-band radar interaction with the microburst have been performed and results of that study are presented. Algorithm performance indetection of both 'wet' and 'dry' microbursts is presented. Author

**N93-19607*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**NASA EXPERIMENTAL AIRBORNE DOPPLER RADAR AND REAL TIME PROCESSOR FOR WIND SHEAR DETECTION**
Philip H. Schaffner, Mark A. Richards (Georgia Tech Research Inst., Atlanta.), William R. Jones, and Lucille H. Crittenden (Research Triangle Inst., Hampton, VA.) *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 477-498 (For primary document see N93-19590 06-03)
Avail: CASI HC A03/MF A06; 28 functional color pages

The topics are presented in viewgraph form and include the following:

experimental radar system capabilities; an experimental radar system block diagram; wind shear radar signal and data processor (WRSDP); WRSDP hardware architecture; WRSDP system design goals; DSP software development tools; OS-9 software development tools; WRSDP digital signal processing; WRSDP display operational modes; WRSDP division of functions; structure of WRSDP signal and data processing algorithms; and the wind shear radar flight experiment. Author

**N93-19608*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**GROUND CLUTTER MEASUREMENTS USING THE NASA AIRBORNE DOPPLER RADAR: DESCRIPTION OF CLUTTER AT THE DENVER AND PHILADELPHIA AIRPORTS**

Steven D. Harrah, Victor E. Delnore (Lockheed Engineering and Sciences Co., Hampton, VA.), Michael S. Goodrich (Lockheed Engineering and Sciences Co., Hampton, VA.), and Chris VonHagel *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 499-516 (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

Detection of hazardous wind shears from an airborne platform, using commercial sized radar hardware, has been debated and researched for several years. The primary concern has been the requirement for 'look-down' capability in a Doppler radar during the approach and landing phases of flight. During 'look-down' operation, the received signal (weather signature) will be corrupted by ground clutter returns. Ground clutter at and around urban airports can have large values of Normalized Radar Cross Section (NRCS) producing clutter returns which could saturate the radar's receiver, thus disabling the radar entirely, or at least from its intended function. The purpose of this research was to investigate the NRCS levels in an airport environment (scene), and to characterize the NRCS distribution across a variety of radar parameters. These results are also compared to results of a similar study using Synthetic Aperture Radar (SAR) images of the same scenes. This was necessary in order to quantify and characterize the differences and similarities between results derived from the real-aperature system flown on the NASA 737 aircraft and parametric studies which have previously been performed using the NASA airborne radar simulation program. Author

**N93-19609*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**SPECTRUM CHARACTERISTICS OF DENVER AND PHILADELPHIA GROUND CLUTTER AND THE PROBLEM OF DISTINGUISHING WIND SHEAR TARGETS FROM MOVING CLUTTER**

Anne I. Mackenzie *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 517-540 (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

Spectral analysis of 1991 wind shear flight data has provided information about the power spectral density, spectral width, and velocity of ground clutter detected by the wind shear radar at several major airports. Ground clutter must be recognized and separated from weather targets before wind shear can be computed. Information will be presented characterizing and comparing ground clutter and weather target spectra. The information includes (1) spectral widths of stationary ground clutter seen at various scan and tilt angles, (2) power spectral density and velocity of moving ground clutter relative to the stationary ground clutter, and (3) spectral widths and velocities of weather targets. A summary of numerical results in the form of histograms and example numerical results in the form of spectral plots are presented. Author

**N93-19610*#** Research Triangle Inst., Hampton, VA.

**COMPARISON OF SIMULATED AND ACTUAL WIND SHEAR RADAR DATA PRODUCTS**

Charles L. Britt and Lucille H. Crittenden *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 541-560 Original contains color illustrations (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

Prior to the development of the NASA experimental wind shear radar system, extensive computer simulations were conducted to determine the performance of the radar in combined weather and ground clutter environments. The simulation of the radar used analytical microburst models to determine weather returns and synthetic aperture radar (SAR) maps to determine ground clutter returns. These simulations were used to guide the development of hazard detection algorithms and to predict their performance. The structure of the radar simulation is reviewed. Actual flight data results from the Orlando and Denver tests are compared with simulated results. Areas of agreement and disagreement of actual and simulated results are shown. Author

**N93-19611*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**NASA AIRBORNE RADAR WIND SHEAR DETECTION ALGORITHM AND THE DETECTION OF WET MICROBURSTS IN THE VICINITY OF ORLANDO, FLORIDA**

Charles L. Britt (Research Triangle Inst., Hampton, VA.) and Emedio M. Bracalente *In its* Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference Part 1 Sep. 1992 p 561-586 (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

The algorithms used in the NASA experimental wind shear radar system for detection, characterization, and determination of windshear hazard are discussed. The performance of the algorithms in the detection of wet microbursts near Orlando is presented. Various suggested algorithms that are currently being evaluated using the flight test results from Denver and Orlando are reviewed. Author

**N93-19612*#** Clemson Univ., SC. Dept. of Electrical and Computer Engineering.

**SIGNAL PROCESSING FOR AIRBORNE DOPPLER RADAR DETECTION OF HAZARDOUS WIND SHEAR AS APPLIED TO NASA 1991 RADAR FLIGHT EXPERIMENT DATA**

Ernest G. Baxa, Jr. *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Fourth Combined Manufacturers' and Technologists' Conference, Part 1 Sep. 1992 p 587-613 (For primary document see N93-19590 06-03)

Avail: CASI HC A03/MF A06; 28 functional color pages

Radar data collected during the 1991 NASA flight tests have been selectively analyzed to support research directed at developing both improved as well as new algorithms for detecting hazardous low-altitude windshear. Analysis of aircraft attitude data from several flights indicated that platform stability bandwidths were small compared to the data rate bandwidths which should support an assumption that radar returns can be treated as short time stationary. Various approaches at detection of weather returns in the presence of ground clutter are being investigated. Non-coventional clutter rejection through spectrum mode tracking and classification algorithms is a subject of continuing research. Based upon autoregressive modeling of the radar return time sequence, this approach may offer an alternative to overcome errors in conventional pulse-pair estimates. Adaptive filtering is being evaluated as a means of rejecting clutter with emphasis on low signal-to-clutter ratio situations, particularly in the presence of discrete clutter interference. An analysis of out-of-range clutter returns is included to illustrate effects of ground clutter interference due to range aliasing for aircraft on final approach. Data are presented to indicate how aircraft groundspeed might be corrected from the radar data as well as point to an observed problem of groundspeed estimate bias variation with radar antenna scan angle. A description of how recorded clutter return data are mixed with simulated weather returns is included. This enables the researcher to run controlled experiments to test signal processing algorithms. In the summary research efforts involving improved modelling of radar ground clutter returns and a Bayesian approach at hazard factor estimation are mentioned. Author

**N93-19647#** Lockheed Aeronautical Systems Co., Burbank, CA.

**A LITERATURE SURVEY OF AIRBORNE VEHICLES IMPACTING WITH WATER AND SOIL: HEAD INJURY CRITERIA AND SEVERITY INDEX DEVELOPMENT OF COMPUTER PROGRAM KRASH Final Report, Nov. 1987 - May 1989**

G. Wittlin and M. A. Gamon Jul. 1992 98 p

(Contract DTFA03-84-C-00004)

(DOT/FAA/CT-90/24) Avail: CASI HC A05/MF A02

A two part study to identify KRASH code requirements for analyses of structure/terrain interaction and head/structure interaction is described. The literature survey of water and soil impact methodology is presented. The reports are reviewed with regard to incorporation of code modifications to program KRASH. A total of 28 water impact reports were reviewed. In the area of water impact, the representation of a transport airplane lower fuselage as a wedge-shaped planning surfaced is discussed. A relationship is developed between vertical force and depth of fuselage penetration. Forty soil impact related reports were reviewed in the survey. For soil impact the two potential approaches described include: (1) empirical definition of soil pressure versus depth; and (2) theoretical definition of soil as a viscoelastic medium. For the head/structure impact assessment, the Head Injury Criteria (HIC) and Severity Index (SI) calculations are added to program KRASH. The approach, equations, and flow diagrams associated with a simple, single degree-of-freedom model of a mass impacting a surface with a given velocity is described. Author

**N93-19653#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.

**AIRCRAFT ACCIDENTS: TRENDS IN AEROSPACE MEDICAL INVESTIGATION TECHNIQUES [LES ACCIDENTS D'AERONEFS: LES TENDANCES EN TECHNIQUES D'INVESTIGATION MEDICALE]**

Sep. 1992 452 p In ENGLISH and FRENCH Symposium held in Cesme, Turkey, 27 Apr. - 1 May 1992

(AGARD-CP-532; ISBN-92-835-0687-1) Copyright Avail: CASI HC A20/MF A04

These proceedings include the Technical Evaluation Report and 58 papers of the Symposium sponsored by the AGARD Aerospace Medical Panel held at the Altin Yunus Hotel, Cesme, Turkey, April 27 - May1 , 1992. Since the commencement of aviation, accidents have occurred for a variety of reasons in both fixed- and rotary-wing aircraft. As the complexity of aviation systems increased, so did the task of investigating aircraft accidents. At the same time, advanced techniques in aviation and weapon systems have exacerbated greatly the physiological and cognitive demands on aircrews. The result is that aircraft accidents due to material causes have diminished progressively while the percentage of human factor-caused accidents has not. For individual titles, see N93-19654 through N93-19710.

**N93-19654#** Army Personnel Research Establishment, Farnborough (England).

**HUMAN FACTORS IN AIRCRAFT ACCIDENT INVESTIGATION**

Roger Green *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)

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An opening speech of the meeting is addressed. Two brief basic psychological effects that can cause both pilots and accident investigators to err are discussed. The first is one of the most important psychological causes of human error accidents, and is the family of effects sometimes referred to as 'hypothesis locking' or 'confirmation bias'. The second effect, or set of effects, concerns the social factors that influence crew behavior on flight decks, and the example from the database of the UK Confidential Human Factors Incident Reporting Programme (CHIRP). I.I.C.

**N93-19655#** Swedish Air Force, Stockholm.

**HOW DO WE INVESTIGATE THE HUMAN FACTOR IN AIRCRAFT ACCIDENTS?**

Kristina Pollack *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p (For primary document see N93-19653 06-03)

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Today, the reality is that two-thirds of accidents and incidents are related to Human Factors. The concept of Human Factors is hard to define, identify or verify and definitions of the concept are as many as its advocates. In order to be aware of the complexity of the Human Factor in defining the root cause of an accident, to sub-categorize the concept, to be able to analyze and to see the trends over a period of time, trained experts are required. The findings, including the Human Factor findings, must influence the total report, which will form the basis of future flight safety work. I.I.C.

**N93-19656#** Norton AFB Ballistic Missile Office, CA.

**A METHOD FOR INVESTIGATING HUMAN FACTOR ASPECTS OF MILITARY AIRCRAFT ACCIDENTS**

Richard A. Levy *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 19 p (For primary document see N93-19653 06-03)

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The term 'human factor' denotes the relationship between the aviator, the aircraft and the environment. This covers a very large and complex interrelated panorama of factors, to include as an example, personal stress, training, physiology, aircraft flight characteristics, judgement and decision making, experience, nutrition, fatigue, and motivation. A major concern in assessing the significance of any particular human factor, or combination of factors, is the method employed in the collection of the raw data and subsequent analysis. The method of investigation and analysis employed by the U.S. Air Force, the problems inherent in this approach, and a joint, NATO human factors aircraft accident investigation methodology and program are discussed. I.I.C.

**N93-19657#** Canadian Forces Headquarters, Ottawa (Ontario).

**THE HUMAN FACTOR PROBLEM IN THE CANADIAN FORCES AVIATION**

J. F. David *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 9 p (For primary document see N93-19653 06-03)

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A 10-year analysis of human factor errors in the Canadian Air Force and where efforts should be concentrated to reduce human error are discussed. A 10-year analysis of our ground accidents and interestingly, close to 84 percent of the causes were related to personnel errors. Although the overall supervisory error was approximately 10 percent, it represented only 6 percent of the personnel error in air occurrences and close to 19 percent in ground occurrences. It was concluded that aviation psychology needs more investment. Furthermore, we cannot progress effectively in this area unless an extensive human factor data base is developed over coming decades. A human factor data base will allow for meaningful and more objective assessment by the decision makers and leaders. I.I.C.

**N93-19658#** Royal Netherlands Air Force, The Hague.

**UNDERLYING CAUSES OF ACCIDENTS: CASUAL NETWORKS**

Ferdinand H. J. I. Rameckers *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)

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This paper describes recent thinking about Accident Causation Theory, accident investigation and accident prevention. The central notion is that human error as the primary cause of accident causation, prevails at all levels in any complex organization and that accidents are caused by a unique network of factors, generated not only by unsafe acts of front-line operators, but also by fallible management decisions and all kinds of (psychological) preconditions that exist in the operations environment. New approaches aiming at possibilities of proactive prevention are briefly touched. Author

**N93-19659#** Dassault Aviation, Istres (France).

**AID IN INVESTIGATION BY FIGURE ANIMATION [AIDE A L'ENQUETE PAR FIGURATION ANIMEE]**

Jean Coureau *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 11 p In FRENCH (For primary document see N93-19653 06-03)

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The investigation into the causes of accidents is an increasingly difficult undertaking because the human factors become largely prevalent in more than 75 percent of cases and everyone knows that they are delicate to interpret. Moreover the hardware is more and more comprised of electronics and software, so that the physical traces are often non-existent, outside of the parameters recorded on the 'crash recorder' and CVR. At the time of the analysis of the listings or layouts, the independent or little correlated parameters are interpreted easily, such as the driving mode and temperature. On the other hand, the quickly evolving and highly correlated parameters are harder to approach: the response of an aircraft to longitudinal and transverse stresses combined, for example. Software allowing the

presentation on a graphic console of the parameters recorded from the pilot's viewpoint and animated in real time has been developed on the basis of a test by Dassault Aviation in Istres. The result satisfies all hopes: it is possible to view the flight at normal speed, at idle, accelerated, or to stop an image. The instrument panel is similar to that of the aircraft, the lever and the handle move as in reality. The horizon of the landscapes gives paravisual information of the movements of the aircraft. The investigators really 'feel' the way in which the pilot reacted to the movements of the aircraft or the events which occurred: signs of carelessness, nervousness or even a change of pilot at the controls on a two-seater. In another presentation, a model seen from the outside reproduces the movements of the aircraft for complex trend analysis: spins, stalls, etc. Finally layouts, with or without zoom, give the evolution of the desired parameters in analog, as on paper, but with more flexibility of use. A video film presenting some typical flight cases is intended to emphasize the advantages of this kind of animation. A description of the operations of data acquisition of a military aircraft is given. A flow chart of the software for presentation on a graphic console is provided. Author

**N93-19660#** Gulhane Skeri Tip Akademisi, Eskisehir (Turkey). Aerospace Medical Center.

**ASSESSMENT OF MORALE IN TURKISH AIR FORCE PILOTS WITH TWO CLINICAL PSYCHOLOGICAL TESTS** **c53**

Muzaffer Cetinguc, Sait Deger, and O. Yalug *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)

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In popular understanding good morale is equal to the perception of well being, lack of distress and absence of anxiety and depression. Actually the term morale is related to anxiety and depression. The rational of this survey is to assess numerically stress levels by using anxiety and depression scores. 345 active duty Turkish Air Force (TuAF) pilots and 70 non-flying air force officers as control group, have been taken into this study. 'State Trait Personality Inventory' (STPI-Spielberger) and 'Zung Depression Scale' (ZDS) were applied to both groups in 1988. As an unexpected result, the flyer group has reflected lower scores than the non-flyers. Different explanations are available but they are most likely to be related to high motivation and job satisfaction as well as ego strengths of flyers. These factors can elevate the ability to cope with stressful conditions. Author

**N93-19661#** Department of Transport (England). Air Accidents Investigation Branch.

**737-400 AT KEGWORTH, 8 JANUARY 1989: THE AAIB INVESTIGATION**

R. D. G. Carter *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 15 p (For primary document see N93-19653 06-03)

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A Boeing 737-400, jet transport aircraft, G-OBME, carrying 8 crew and 118 passengers, crashed near Kegworth, Leicestershire, on 8th January 1989. Of the 126 occupants, 47 died as a result of the accident and a further 74 suffered serious injury. This paper describes the structures and survivability investigations conducted into this accident by the Air Accidents Investigation Branch (AAIB) of the UK Department of Transport and reproduces the 11 AAIB Safety Recommendations (out of a total of 31 in the final report) concerning crashworthiness and survivability. This paper also describes the study performed for this investigation by the Cranfield Impact Centre, using the KRASH computer code to quantify impact pulses. The results of the KRASH work supported the AAIB recommendations in the G-OBME report and form the background to a program at the Cranfield Impact Centre to facilitate the use of impact computer codes in aircraft accident investigations. Author

**N93-19662#** H. W. Structures Ltd., Pitsea (England).

**OCCUPANT KINEMATICS SIMULATION OF THE KEGWORTH AIR ACCIDENT** **c54**

R. Haidar and N. Rock *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)

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The use of computer simulation in the investigation of the crash of Boeing 737-400 at Kegworth has highlighted the importance of the technique in aiding the accident and medical investigations. The analysis has shown the importance of adopting a full brace position for crash landing thus offering significant protection against injury. The major value of the study has shown that a unique and definitive estimation of the occupant kinematics and the effects on the crash victims are possible for an aircrash. Author

**N93-19663#** Queens Medical Centre, Nottingham (England). Dept. of Orthopaedic and Accident Surgery.

**CAN INJURY SCORING TECHNIQUES PROVIDE ADDITIONAL INFORMATION FOR CRASH INVESTIGATORS?** **c52**

J. M. Rowles, W. A. Wallace, and D. J. Anton (Royal Aerospace Establishment Farnborough (England)) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 10 p (For primary document see N93-19653 06-03)

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The Abbreviated Injury Score (AIS) and Injury Severity Score were calculated for all passengers and crew of the M1 Kegworth aircraft crash. Regional scores were significantly higher in nonsurvivors than survivors of the impact. Mortality and ISSs were found to correlate with the structural damage sustained by the aircraft. The use of injury scoring has highlighted variations in the severity of injuries sustained by occupants involved in an impact aircrash. This information has demonstrated that other factors in addition to the force of the impact were involved in the causation of injury, such as structural integrity, attempts by occupants to protect adjoining passengers, being struck by loose objects and rear facing seats. Author

**N93-19664#** Queens Medical Centre, Nottingham (England). Dept. of Orthopaedic and Accident Surgery.

**IS AXIAL LOADING A PRIMARY MECHANISM OF INJURY TO THE LOWER LIMB IN AN IMPACT AIRCRAFT ACCIDENT?** **c52**

J. M. Rowles, P. Brownson, W. A. Wallace, and D. J. Anton (Royal Aerospace Establishment Farnborough (England)) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)

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Following the crash of a Boeing 737-400 aircraft on the M1 motorway near Kegworth, England, on 8 January 1989, it became apparent that a large number of pelvic and lower limb injuries had been sustained by the survivors. Had there been a fire this would have severely hindered the ability of the occupants to escape. The mechanism of pelvic and lower limb injuries in impact accidents has been related to failing of the limbs and axial loading of the femur. The validity of axial loading of the femur as a primary mechanism of femoral fracture in an impact aircraft accident is questioned. Two methods of study have been used to investigate the impact biomechanics of the pelvis and lower limb: clinical review and impact testing using anthropomorphic dummies. Our study suggests that in the presence of intact occupant protection systems, bending of the femur over the front spar of passenger seats is the primary mechanism of causation of femoral fractures. Occupant protection systems designed for civil aircraft should be modified to accommodate loading of the femur over the front of the seat. Author

**N93-19665#** Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands). TNO Crash-Safety Research Centre.

**OCCUPANT SIMULATION AS AN ASPECT OF FLIGHT SAFETY RESEARCH** **c54**

J. J. Nieboer, J. Wismans, and R. Verschut *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 9 p (For primary document see N93-19653 06-03)

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In the field of flight safety research there is a growing interest for mathematical simulation of human response and injuries associated with survivable aircraft accidents. A mathematical tool can be very helpful to evaluate and improve on-board restraint systems or to assess the effectiveness of different seat designs. The passenger brace position, being a human factor, can be evaluated efficiently as well. MADYMO is a well accepted integrated multibody/finite element program for Crash Victim Simulation. Recently the two-dimensional version of MADYMO was successfully applied for reconstruction of seat and passenger behavior during the M1 Kegworth air accident. In this paper a brief description of MADYMO as well as three flight safety applications are presented. Special attention is given to the application concerning a dynamic seat test involving

a 50th percentile Hybrid 2 dummy and a greater than P3/4 dummy, representing a nine-month-old child, seated in a child seat. The MADYMO model used for this application was validated on the basis of sled test results. It can be learned that MADYMO is capable of predicting passenger and seat response in an aircraft crash environment. A discussion on future developments in this field concludes this paper. Author

**N93-19666#** Arup (Ove) and Partners, London (England).
**COMPUTER AIDED METHODS FOR SIMULATING OCCUPANT RESPONSE TO IMPACT USING OASYS DYNA3D c54**
T. J. Keer, R. M. V. Sturt, and B. D. Walker *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 16 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A03/MF A04

Numerical simulation can play a key role in design for crashworthiness and accident investigation. This paper presents recent work in the development of occupant simulation techniques for the automotive industry, and describes how the same techniques may be applied to aircraft crashworthiness. Author

**N93-19667#** Applied Physics, Inc., Nanuet, NY.
**DESIGN/DEVELOPMENT OF AN ENHANCED BIODYNAMIC MANIKIN c54**
Paul H. Frisch and William Boulay *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 9 p (For primary document see N93-19653 06-03)
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This publication details the design and development of an enhanced manikin form incorporating all instrumentation and data acquisition capabilities to record and reconstruct the six degree of freedom response of the manikin. The manikin is designed to enhance biofidelity and provided a three dimensional biodynamic response, attempting to approximate that of the human. These objectives resulted in the implementation of an omnidirectional response flexible spine and pelvis assembly. Author

**N93-19668#** Simula, Inc., Phoenix, AZ.
**IMPROVING MANIKIN BIOFIDELITY c54**
Caroline VanIngen-Dunn, Marvin Richards, and Ints Kaleps (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 14 p (For primary document see N93-19653 06-03)
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Two programs demonstrating the feasibility of improving the dynamic response of ejection system test manikins have been completed for the U.S. Air Force. The first program developed a manikin neck that has greater biofidelity during vertical impact conditions than currently available manikin necks. The second program developed manikin arms and legs with proper mass and mass moments of inertia to improve dynamic response. Both programs were conducted to support the development of the U.S. Air Force's Advanced Dynamic Anthropomorphic Manikin (ADAM). Author

**N93-19669#** Department of Transport (England). Transport Research Lab.
**THE DESIGN AND USE OF AUTOMOTIVE CRASH TEST DUMMIES c54**
A. K. Roberts *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)
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Anthropomorphic crash test dummies have been used by the automotive industry for many years in order to develop safer road transport. Accident investigations have shown how vehicle design has improved, with the number and severity of road casualty injuries decreasing despite increased use of road transport. Several different types of dummies of differing levels of sophistication are used to approve vehicles to a number of different standards and regulations. Dummies are used either to approve restraint systems at the component level or in full vehicle impact tests. Various performance criteria must be met by anthropomorphic test dummies, and these criteria are discussed with reference to the interests of the vehicle designer, the biomechanical engineer and the legislative authority. The paper concentrates on the approach to dummy design used to develop the new European Side Impact Dummy EUROSID-1. The methodology used to develop certification techniques is described as well as the dummy itself. Techniques to calibrate a dummy in terms of predicting human injury risk are reviewed. The techniques described are common to all automotive crash test dummies and can be applied to the design and development of anthropomorphic dummies to be used in other disciplines. Author

**N93-19670#** Biokinetics and Associates Ltd., Ottawa (Ontario).
**AN IMPROVED ANTHROPOMETRIC TEST DEVICE c54**
Tom Gibson, James Newman, John W. Zellner (Dynamic Research, Inc., Torrance, CA.), and Kenneth D. Wiley (Dynamic Research, Inc., Torrance, CA.) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p (For primary document see N93-19653 06-03)
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This paper reviews recent experience with a new test dummy intended principally for use in motorcycle crash testing. Modifications to the Hybrid 3 to better service this particular environment also makes the device potentially suitable in aicraft occupant crash protection assessment. This new ATD contains a 16-channel on-board data acquisition system, lower extremities that are capable of monitoring for leg and knee injuries, a more flexible lumbar spine, a penetration monitoring abdomen, a deformable thorax with improved motion sensing capabilities and a neck with improved flexion and extension bending response. The femur and tibial complex are constructed of frangible elements whose biomechanical responses are based on available cadaver data. The knee is designed with fusible links that fail at load levels commensurate with that of human knee ligaments. The test device has been used in full-scale crash tests as well as limited laboratory validation tests. This paper illustrates the potential of this injury monitoring device for aerospace applications as well as identifying areas of future work. Author

**N93-19671#** Royal Netherlands Air Force, Volkel. Inst. of Aviation Medicine.
**THE APPLICATION OF HYBRID 3 DUMMY TO THE IMPACT ASSESSMENT OF A FREE-FALL LIFEBOAT c54**
D. H. Glaister, P. J. Waugh, and L. Neil *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)
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A requirement to monitor occupant forces during the launch of a free-fall lifeboat has led to the definition of a transportable instrumented dummy and data-acquisition system. Good quality data have been recorded during 21 free-falls from which advice has been given concerning the acceptability of launch forces for both injured and non-injured personnel. Head restraint is not considered in the International Maritime Organization's current assessment criteria for free-fall lifeboats, but was shown to have a pronounced effect on head and neck forces, with significant overshoots being seen when no restraint was available. It is concluded that the dummy and data-acquisition system developed for these trials offers a valid means for assessing impact forces and injury risk in novel impact environments such as the launch of a free-fall lifeboat. Author

**N93-19672#** New Orleans Univ., LA. Naval Biodynamics Lab.
**A NEW INSTRUMENTATION SYSTEM FOR MEASURING THE DYNAMIC RESPONSE OF THE HUMAN HEAD/NECK DURING IMPACT ACCELERATION c54**
M. S. Weiss, G. C. Willems, S. J. Guccione, Jr., C. J. Mugnier, and M. E. Pittman *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)
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Recently developed angular motion sensors, based on the laws of magnetohydrodynamics, have potential application in biodynamic research. These sensors were tested on the Naval Biodynamics Laboratory's (NBDL) vertical accelerator, using the Hybrid 3 manikin as the test subject. The sensors were used to measure the manikin's head motion in three dimensions. Experiments were conducted at impact levels up to 13g in the vertical (+Z) direction. Data was collected using both the new sensors and the standard NBDL package of nine linear accelerometers. A new method for obtaining initial position and orientation information using still photogrammetry was also evaluated. The analyses of the tests show that the new sensor and photogrammetry system compared well with the nine accelerometer array and the direct photographic measurement of displacement. Comparisons were made between measurements of

acceleration, velocity and displacement. The new system yielded equivalent and, in some instances, more accurate results. This study extends the results of previous preliminary testing and confirms the value of the new system as a simpler, more accurate and portable replacement for the old one. Author

**N93-19673#** Air Force Wright Aeronautical Labs., Langley AFB, VA. Aerospace Medicine Div.

**HUMAN FACTORS CAUSES AND MANAGEMENT STRATEGIES IN US AIR FORCE F-16 MISHAPS 1984-PRESENT**

R. D. Vanderbeek *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 5 p (For primary document see N93-19653 06-03)

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The F-16 was introduced into the US Air Force in 1975 as the YF-16. It began significant operational employment in the early 1980's. For this paper statistics reflect mishaps since 1984, an arbitrary starting point reflecting mature operational F-16 employment as the venerable F-4 was being phased into retirement. A review of all F-16 Class 'A' mishaps (i.e. loss of aircraft, life, or damage exceeding $1 million) from January 1984 through the end of March 1992 is presented. These mishaps are first listed within traditional causal categories. The mishaps where operator factor was cited are then recategorized into an expanded umbrella framework reflecting operationally meaningful subsets of situational awareness (SA). This SA framework more clearly demonstrates the role and importance of pilot attention and broader awareness in mishap avoidance. A program developed by Tactical Air Command, United States Air Force, to improve pilot attention and awareness is then discussed. Author

**N93-19674#** Royal Norwegian Air Force, Blindern.

**F-16 ACCIDENTS: THE NORWEGIAN EXPERIENCE**

Suzanne Klaveness and Harald T. Andersen *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p (For primary document see N93-19653 06-03)

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Investigation reports from F-16 mishaps in the Royal Norwegian Air Force have been studied. In order to evaluate and improve the human factor information contained in the written records of F-16 mishaps, we have examined all information available in the Royal Norwegian Air Force for a ten year period, 1981 to 1990. Author

**N93-19675#** Belgian Air Force, Beauvechain.

**CATEGORY A F-16 ACCIDENTS IN THE BELGIAN AIR FORCE [LES ACCIDENTS F-16 DE CATEGORIE A A LA FORCE AERIENNE BELGE]**

R. Delhaye and P. Vandenbosch *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p In FRENCH (For primary document see N93-19653 06-03)

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The Belgian Air Forces have been flying on F-16's since 1979; a review of all the class A mishaps is realized. This global study points out a particular human factor that could not be found in a single analysis of each mishap. Author

**N93-19676#** Centre d'Essais en Vol, Bretigny-Air (France).

**AIR ACCIDENTS IN THE FRENCH AIR FORCE [ACCIDENTS AERIENS DANS L'ARMEE DE L'AIR FRANCAISE (1977-1990): INFLUENCE DES AERONEFS DE LA NOUVELLE GENERATION]**

G. Ossard, H. Marotte, J. M. Clere, and J. Y. Grau *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 10 p In FRENCH (For primary document see N93-19653 06-03)

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This assessment of the air accidents in the French Air Force covered the period 1977-1990. During this period, combat aircraft of the new generation were brought into service without an important variation of the number of air accidents being observed, although the rate of accidents per 10,000 hours of flight appears higher for new aircraft. The human factor remains the main cause of the air accidents in the combat category, but seems to be implied with less frequency with aircraft of the new generation. Mortality during combat accidents has tended to decrease regularly since 1987. Author

**N93-19677#** Belgian Air Force, Brussels.

**COMBAT AND TRAINING AIRCRAFT CLASS A MISHAPS IN THE BELGIAN AIR FORCE 1970-1990**

I. Biesemans and P. Vandenbosch *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 12 p (For primary document see N93-19653 06-03)

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The authors reviewed the files of 114 combat and training aircraft class A mishaps in the Belgian Air Force during the period from 1970-1990 with the cooperation of the office of the 'Belgian Accident Investigation Board'. They searched for the causes of these accidents i.e. Operational related, Logistics related and environmental factors, as well as contributory factors which played a role in these mishaps. While considering the causes of these accidents, they found that 71 percent were operational related, 22 percent logistics related and 7 percent were caused by environmental factors, such as birdstrike, foreign object damage (FOD) to the engine and unknown. From the 23 training aircraft lost, only one single aircraft crash was caused by a technical failure. The overall attrition rate for the period was 1.08/10.000 Aircraft Hours (A/C) hours, being 1.43/10.000 for combat A/C and 0.55/10.000 for training A/C. The introduction of the agile F-16 fighter in the early 1980's, coinciding with a serious decrease of the annual flying time and an undermanning in terms of experienced pilots in the squadrons was most probably responsible for the negative trend in the evolution of the annual attrition rate until 1989. Although the Belgian Air Force remained two years without a major accident, it must resolutely continue its effort in the field of accident prevention. By extending the time spent by aircrews in an operational squadron, supervised by experienced pilots, the Belgian Air Force should be able to reduce class A mishaps in the future. Author

**N93-19678#** Army Safety Center, Fort Rucker, AL.

**UNDERLYING CAUSES OF HUMAN ERROR IN US ARMY ROTARY WIND ACCIDENTS**

Daniel T. Fitzpatrick *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)

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Human error has been a causal factor in 80 percent of U.S. Army aviation accidents. The focus of an accident investigation is to identify the task errors and related system inadequacies that contributed to the accident occurrence. Within the U.S. Army, crew error aviation accidents have been attributed to one of five reasons: individual failure (41 percent), leader failure (27 percent), standards failure (15 percent), training failure (12 percent), or other failure (5 percent). This study describes the most frequently occurring aircrew task errors and associated problem areas causing U.S. Army rotary wing accidents from FY-84 through FY-91. A total of 554 accidents occurred, resulting from 906 aircrew errors. The three most frequently occurring task errors involved improper decision, improper attention, and inadequate communication. Together, they accounted for one half of the total number of identified errors. The most frequently reported problem areas were inadequate crew coordination and improper scanning, which accounted for almost 40 percent of the errors. There were minor differences noted for problem areas based on aircraft type, time of occurrence, and responsible aircrew member. The U.S. Army Aviation Center has introduced corrective measures that address these problem areas. If successful, these corrective measures should reduce crew error, resulting in fewer accidents and a savings in personnel and equipment. Author

**N93-19679#** Air Force Human Resources Lab., Brooks AFB, TX.

**EPIDEMIOLOGY OF UNITED STATES AIR FORCE SPATIAL DISORIENTATION ACCIDENTS: 1990-1991** **c53**

Terence J. Lyons, William R. Ercoline, James E. Freeman, and Kent K. Gillingham *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 11 p (For primary document see N93-19653 06-03)

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Spatial disorientation (SD) continues to be a contributing factor to a fairly constant proportion of military aircraft accidents. The United States Air Force (USAF) fielded a new accident investigation reporting form in July 1989, which for the first time specified SD Type 1, Type 2, and Type 3 as possible causes of aircraft accidents. Of a total of 91 major accidents

that occurred over the 2-year period beginning in October 1989, SD contributed significantly to 13 (14 percent). Although this percentage is higher than that reported in previous studies, the actual rate of SD accidents per 100,000 flying hours (.1843) is lower than previously reported. Type 1 SD was the cause of all 13 accidents; 9 of the 13 were fatal; 6 occurred in night or instrument meteorological conditions (IMC) conditions; and 11 involved cockpit attention problems, such as inattention, distraction, or channelized attention. Pilot inexperience did not appear to be a factor: average total flying time for the 13 pilots was 1,687 hours. Coding for SD on accident investigation reporting forms was not consistent. There were both individual differences between flight surgeons and pilots, and trends in reporting overtime. There is, however, a consensus that SD represents a major problem in military aviation. A scientific approach to this important problem would be facilitated if agreement could be reached on definitional and semantic issues. Author

**N93-19680#** Army Air Corps, Stockbridge (England).
**DISORIENTATION AND FLIGHT SAFETY: A SURVEY OF UK ARMY AIRCREW** **c53**
S. J. Durnford *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 14 p (For primary document see N93-19653 06-03)
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This paper reports the finding of a questionnaire survey intended to gather disorientation. 440 UK Army aircrew were targeted and the response rate was 79 percent. The survey confirmed the high incidence of disorientation (24 percent of aircrew had suffered at least one episode severe enough to have put flight safety at risk at some point during their flying career and 6 percent had suffered such an episode in the previous 4 months). Only 10 percent had never suffered any disorientation. I.I.C.

**N93-19681#** Sextant Avionique, Saint Medard en Jalles (France).
**OTOLITHIC ILLUSIONS ON TAKEOFF AND VISUAL INFORMATION: REFLECTIONS IN CONNECTION WITH AN AIR ACCIDENT CASE [ILLUSIONS OTOLITHIQUES AU DECOLLAGE ET INFORMATIONS VISUELLES: REFLEXIONS A PROPOS D'UN CAS D'ACCIDENT AERIEN]** **c53**
A. Leger, C. Martin, and R. Parus *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p In FRENCH (For primary document see N93-19653 06-03)
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Otolithic illusions on takeoff (takeoff illusions) have long been known as causes of air accidents. They originate in acceleration + Jx of the aircraft which, while adjusting to the gravity vector, produces an otolithic stimulation generating an excessive feeling of being pulled (somatogravic illusion). This type of illusion appears primarily when the visual references are insufficient (night takeoff, foggy environment). An air accident having led to the loss of a modern combat aircraft is reported. The circumstances and the various parameters of flight (accelerations Jx and Jz, speed, trajectory and altitude, actions of the pilot, etc.) are analyzed. From these data, the resulting otolithic stimulation undergone by the pilot during the flight was reconstituted. The evolution of this stimulation makes it possible to explain perfectly the actions carried out by the pilot, making this accident a typical example of takeoff illusion. The analysis of this air accident shows that the pilot never seemed to have used the visual attitude information presented by the head high visor in the aircraft. Beginning with these elements, a reflection of the visual information of the space orientation presented in the sights is carried out. It results in the consideration of various solutions likely to reduce the risks of confusion. The introduction of display systems connected to the head poses a certain number of new problems in this field, but also opens up interesting prospects. Author

**N93-19682#** Centre d'Enseignement et de Recherches des Industries Alimentaires et Chimiques, Brussels (Belgium).
**COGNITIVE FACTORS IN THE AIR EVENTS OF THE AIR FORCE DURING THE LAST DECADE [LES FACTEURS COGNITIFS DANS LES EVENEMENTS AERIENS DE L'ARMEE DE L'AIR AU COURS DE LA DERNIERE DECENNIE]** **c53**
J. Y. Grau, R. Amalberti, and J. P. Menu *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p In FRENCH (For primary document see N93-19653 06-03)
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Accident prevention has been a continuous concern since the early beginnings of aviation. Early efforts in prevention have been devoted to system reliability, then to physiological factors. Improvements in both these directions lead to consider cognitive factors as the main source of accidents. Prevention effort must take into account pilots' cognitive processes. In depth cognitive analysis of aircraft accidents serve to point out error mechanisms. Statistics complete this figure showing the respective occurrence frequency of these mechanisms, therefore orient the preventive actions. Such an approach, focused on the cognitive factors involves to define a specific analysis grid from psychological theories on human error. The elaborated grid is the basis to design a cognitive oriented data base. Author

**N93-19683#** German Air Force, Fuerstenfeldbruk (Germany).
**EFFECTS OF MEDIUM BLOOD ALCOHOL LEVELS ON PILOTS' PERFORMANCE IN THE SEA KING SIMULATOR MK-41** **c52**
M. Kraemer *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p (For primary document see N93-19653 06-03)
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A number of 20 military pilots drank certain amounts of alcohol until the blood alcohol concentrations reached a level of about 0.8 o/oo. After that they had to fly an IFR mission using the flight simulator for 2 1/2 hours. They were told to perform the complete program of navigation and flight operations and also communications with, for example, air traffic control (ATC). During the simulated flight programmed technical failures occurred concerning the instruments and the engine. The reactions of pilots and the cause were registered. The results were obtained by summarizing false reactions. Significant differences in the number of wrong reactions due to alcohol consumption were registered. Author

**N93-19684#** Naval Aviation HQ, Yeovil (England).
**ROYAL NAVAL HELICOPTER DITCHING EXPERIENCE**
A. P. Steele-Perkins, R. P. Johnston (Royal Naval Air Medical School, Hillhead , England ), and P. Barton (Royal Naval Air Medical School, Hillhead , England ) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)
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Controlled or uncontrolled water entry (ditching) by Royal Naval helicopters continues to occur and is a significant loss of resource - both human and aircraft. Accidents over a ten year period (1982-1991) are listed, causation and trends analyzed, and preventative measures put forward, as are initiatives to increase post ditching survivability. Author

**N93-19685#** Defence and Civil Inst. of Environmental Medicine, North York (Ontario).
**CANADIAN FORCES HELICOPTER DITCHINGS: 1952-1990**
C. J. Brooks *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 12 p (For primary document see N93-19653 06-03)
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In 1982, Brooks and Rowe completed a 20 year retrospective review of the survival of all Canadian Military aircrew from ditching, parachuting or ejecting into both fresh and sea water, including the penetration of ice on frozen rivers and lakes. For the purpose of that study, all of these mishaps were classified as water accidents. The authors originally had intended to examine all water accidents back to 1952, but due to integration of the services and coincidental amalgamation of the RCAF Institute of Aviation Medicine and the Defence and Civil Institute of Environmental Medicine data prior to 1962 appeared to have been lost or destroyed. This paper summarizes the Canadian Military experience with ditching helicopters into water over the last 38 years. I.I.C.

**N93-19686#** Institut de Medicine Navale, Toulon-Naval (France).
**HELICOPTER ACCIDENTS OVER WATER IN THE NATIONAL NAVY: EPIDEMIOLOGICAL STUDY OVER THE PERIOD 1980-1991 [ACCIDENTS D'HELICOPTERE AU DESSUS DE L'EAU DANS LA MARINE NATIONALE: ETUDE EPIDEMIOLOGIQUE SUR LA PERIODE 1980-1991]**
Pierre Giry, Pierre Courcoux (Conseil Permanent de la Securite Arienne de la Marine, Paris, France ), and Jean Pierre Taillemite (Aeronautique Navale,

Toulon-Naval, France ) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p In FRENCH (For primary document see N93-19653 06-03)
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During the years 1980-1991, 11 French Navy helicopters ditched in the sea: 3 Super-Frelon, 3 LYNX-WG13, 3 Alouette 3, and 2 Alouette 2, 10 of them being equipped with flottability devices. Structure default was the identified cause of the accident in 2 cases, engine failure in 5 accidents, human error in 5 issues, the last one being unknown. Three accidents occurred at night, the 8 others during day-time. 54 persons (34 crew, 20 passengers) have been involved. The outcome has been: 19 dead or disappeared, 4 wounded and 31 uninjured. The aircraft capsized in 8 out of 11 occurrences, almost immediately after ditching in 6 cases, after a delay long enough for all the crew to escape in 2 cases. In one of these last occurrences, all the crew but 1 survivor (13 people) died (probably from cold exposure). In the other one (ditching in shallow warm waters, close to shore) no casualty occurred (10 safe). Escape problems have been reported in 2 accidents (5 people involved), leading to 3 casualties and 1 injured. Localization of survivors has been a major problem in 1 accident (visibility was so poor that only sound signals could be efficient). Author

**N93-19687#** Naval Air Station, Norfolk, VA. United States Naval Safety Center.

**HELICOPTER CRASH SURVIVAL AT SEA: UNITED STATES NAVY/MARINE CORPS EXPERIENCE 1977-1990**

C. O. Barker, D. W. Yacavone, M. S. Borowsky, and D. W. Williamson *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)
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This paper examines the United States Navy/Marine Corps' (USN) experience with helicopter Class A over water mishaps for the period from 1977 to 1990. There were 137 helicopter Class A flight mishaps over water during this period with an overall survival rate of 83 percent in survivable water crashes. During this period, the USN developed several programs to improve survivability. The helicopter water survival training device (WSTD or 9-D-5 device) was instituted in 1982. The helicopter emergency escape device system (HEEDS) and the helicopter emergency lighting system (HEELS) were implemented in 1987. This study attempts to answer the question whether or not these programs have, in fact, improved survival since their implementation. In addition, the study reviews the types of operational problems encountered with these devices. The results indicate that the WSTD and HEEDS may have contributed to the statistically significant improved survival seen among Navy aircrew in night crashes. They may have also contributed to the improvement (not statistically significant) in survival among passengers in night crashes. The data were inconclusive with respect to the effects of HEELS because of its not being implemented throughout the fleet. Operational problems with these devices were minor and the benefits of each program far outweigh any risks. In fact, in night crashes aircrew had significantly higher likelihood of survival than passengers who were essentially untrained occupants. Other factors, in addition to the devices studied, may have also affected survival probabilities. Author

**N93-19688#** Army Aeromedical Research Lab., Fort Rucker, AL. Biodynamics Research Div.

**CRASH EXPERIENCE OF THE US ARMY BLACK HAWK HELICOPTER**

Dennis F. Shanahan *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 9 p (For primary document see N93-19653 06-03)
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The U.S. Army UH-60A, Black Hawk, helicopter is the first helicopter designed and built to modern crashworthiness standards. During the design of the Black Hawk, all common injury mechanisms were considered, and significant attempts were made to eliminate foreseeable injury hazards. Most important, the aircraft was designed to withstand an 11.6 m/s (38 ft/s) vertical impact without acceleration injury to the occupants or collapse of structure or high mass items into occupied space. Crew and passengers were provided energy attenuating seats and state-of-the-art restraint systems. Head strike zones were considered and potentially injurious objects excluded from these zones. Additionally, the helicopter was equipped with an advanced crash resistant fuel system. First fielded in 1979, the Black Hawk now has accumulated over 1.1 million hours of flight time. Over the 11-year period from 1 October 1979 to 30 September 1990, there have been 75 class A and B mishaps of the UH-60 resulting in 84 fatalities and 121 personnel injured. Systematic analysis of these crashes has accumulated adequate data to assess the effectiveness of the crashworthiness features of the Black Hawk. The Black Hawk has proven itself to be highly crash survivable even in impacts up to 18.3 m/s (60 ft/s) vertical velocity. Most notable have been its structural integrity, tie-down strength of seats and restraint systems, effectiveness of energy absorbing seats and landing gear, effectiveness of the crash resistant fuel system, and retention of high mass items. Mitigating against this has been a higher than predicted accident rate, a markedly increased vertical velocity at impact compared to most other helicopters in use by the U.S. Army, and a tendency for the roof to collapse in high vertical velocity crashes. Author

**N93-19689#** Army Aeromedical Research Lab., Fort Rucker, AL. Biodynamics Research Div.

**US ARMY HELICOPTER INERTIA REEL LOCKING FAILURES**

B. Joseph McEntire *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)
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The inertia reels utilized in U.S. Army helicopters are regulated by MIL-R-8236. This is a performance specification which requires the MA-6 and MA-8 inertia reels to automatically lock when the restraint strap is subjected to an acceleration between 1.5 and 3 G. A review of U.S. Army Safety Center, Fort Rucker, Alabama, mishap data revealed a number of critical and fatal injuries attributed to upper torso flailing that occur in survivable mishaps. Some of these injuries relate directly to the inertia reel either failing to lock or not automatically locking soon enough. Laboratory sled tests have revealed sporadic failures of the inertia reel in both its auto lock and manual lock positions. Inertia reel failures during high horizontal impacts are believed to be due to high rotational velocities of the ratchet wheel which may prevent the locking pawl from properly engaging the sprocket. Inertia reel failures during high vertical impacts are believed to be caused by the low forward acceleration (G(sub x)) transmitted to the shoulder strap because of torso compression, rolling, and slumping. The lack of inertia reel maintenance and calibration procedures potentially allow the automatic lock sensitivity settings to drift to unacceptable levels over time. The influence of operational conditions (i.e., sand, dust, salt fog, temperature, humidity, etc.) on sensitivity settings are unknown. Field tests of 110 inertia reels at Fort Rucker, Alabama, airfields revealed a 24.5 percent failure to lock at the 3 G requirements. Corrective actions being considered include: (1) establishing calibration and maintenance procedures, (2) revising MIL-R-8236 to incorporate dynamic sled tests and (3) development of an inflatable body and head restraint system. Author

**N93-19690#** Army Aeromedical Research Lab., Fort Rucker, AL. Biodynamics Research Div.

**US ARMY'S AVIATION LIFE SUPPORT EQUIPMENT RETRIEVAL PROGRAM REAL WORLD DESIGN SUCCESSES FROM PROACTIVE INVESTIGATION**

Joseph R. Licina and Arthur C. Sippo (Ohio National Guard, Columbus.) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p (For primary document see N93-19653 06-03)
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The U.S. Army Aeromedical Research Laboratory (USAARL) manages the Aviation Life Support Retrieval Program (ALSERP). The purpose of this program is to evaluate and record the efficiency of Aviation Life Support Equipment (ALSE) in the aircraft accident environment with our focus centered on rotary-wing aviation. Personal injury data are correlated with the item of ALSE provided for protection, along with information on the accident kinematics and dynamics. These ALSE items are assessed for damage to determine if the design was adequate, it was manufactured to design, and/or it was properly worn by the crewmember. These data are used by USAARL to identify design deficiencies and to substantiate the need for system improvements. The ALSE sent to USAARL for analysis includes: helmets, crashworthy seats, restraint systems, inertia reels, survival vests, and flight suites from the U.S. Army, and upon request, the Navy,

Air Force, Coast Guard, and other government agencies. The primary item of equipment received by USAARL for analysis remains the helmet due to the identified criticality of head trauma in aviation mishaps. Author

**N93-19691#** Army Aeromedical Research Lab., Fort Rucker, AL.
**THE EFFECTIVENESS OF AIRBAGS IN REDUCING THE SEVERITY OF HEAD INJURY FROM GUNSIGHT STRIKES IN ATTACK HELICOPTERS**
Nabih M. Alem, Dennis F. Shanahan, John V. Barson, and William H. Muzzy, III (Naval Biodynamics Lab., New Orleans, LA.) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 9 p (For primary document see N93-19653 06-03)
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Accident investigation records at the U.S. Army Safety Center were examined to determine the frequency of gunner injuries incurred from striking the optical sighting systems in the Cobra and Apache attack helicopters during survivable mishaps. Among 105 survivable Cobra crashes during 1972-1990, the sighting system was implicated in 9 minor and 5 major injury cases, and 6 fatalities. The Apache had eight survivable mishaps since 1985, with only one gunner fatality which was attributed to the optical relay tube (ORT). In this Apache mishap and in the 11 Cobra cases where major or fatal injuries occurred, we theorized an airbag would have prevented serious injuries. To explore the role of airbags in reducing the severity of head strikes, we conducted 32 sled tests with and without airbags. In all tests without airbags, head strikes of the test manikin were sufficiently severe to cause facial fractures, but not necessarily irreversible brain damage. Airbags proved effective in reducing the severity of head strikes against sighting systems. Using mean values of several indicators of injury severity, airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head angular acceleration peal-to-peak swings by 76 percent in the Cobra tests. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 percent, respectively. The study concludes that an airbag system, specifically designed for the Apache or Cobra, likely would prevent severe or fatal head and chest injuries. Author

**N93-19692*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA. Aeroflight Dynamics Directorate.
**PRE-FLIGHT RISK ASSESSMENT IN EMERGENCY MEDICAL SERVICE (EMS) HELICOPTERS**
R. J. Shively *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)
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The Emergency Medical Service (EMS) industry has been the subject of several television and newspaper articles (Harvey and Jensen, 1987) which emphasized the negative aspects, (e.g., fatalities and high accident rates), rather than the life saving services performed. Until recently, the accident rate of the EMS industry has been five times as high as that of other civil helicopters. This high accident rate has been coupled with the dramatic rise in the number of programs. The industry has built from a single service at its inception in 1972, to over 180 in 1987 (Spray, 1987), to the point that 93 percent of the contiguous U.S. is now covered by some type of EMS service. These factors prompted the National Transportation Safety Board (NTSB) to study the accidents that occurred between May 11, 1978 and December 3, 1986 (NTSB, 1988). The NTSB report concluded that 'Sound pilot judgment is central to safe flight operations.' They further stated that '... factors unique to EMS helicopter operations--such as the influence of the mission itself, program competition, and EMS program management perspectives--can drastically influence pilot judgment during the EMS mission.' One of the most difficult decisions that a pilot must make is whether to accept or decline a mission. A pre-flight risk assessment system (SAFE) was developed at NASA-Ames Research Center for civil EMS operations to aid pilots in making this decision objectively. The ability of the SAFE system to predict mission risk profiles was tested at an EMS facility. The results of this field study demonstrated that the usefulness of SAFE was highly dependent on the type of mission flown. SAFE is now being modified so that it can 'learn' with each mission flown. For example, after flying a mission to a particular site, an EMS pilot would input information about this mission into the system, such as new buildings, wires, or approach procedures. Then, the next time a pilot flew a similar mission or one to the same area, this additional information would be taken into account in computing a risk assessment. Author

**N93-19693#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Berlin (Germany).
**CORRELATIONS BETWEEN ENGINEERING, MEDICAL AND BEHAVIOURAL ASPECTS IN FIRE-RELATED AIRCRAFT ACCIDENTS**
G. Winterfeld *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)
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An overview is given over the present situation in aircraft fire safety as it can be derived from the 73rd AGARD-PEP-Meeting devoted to this subject in 1989. It is characterized by increasing interaction between engineering and medical/behavioral aspects. A scenario for aircraft cabin fires is first developed showing that survival times both from the technical and medical point of view are of the same order of magnitude. Although fire-hardening has contributed much to increased survival times the prospects for further progress from this side diminish. Improvements are expected from improved conditions for emergency evacuations and from occupant protection systems. Modeling studies both on engineering and medical problems are increasingly applied to fire-related problems. The use of water spray systems and smoke hoods are discussed in the paper as well as studies on passenger behavior during evacuations. The combination of medical, behavioral and engineering expertise can be used to promote and optimize passenger protection in fire-related aircraft accidents. Author

**N93-19694#** Laboratoire de Medecine Aerospatiale, Bretigny-sur-Orge (France).
**FIRES ON BOARD AIRCRAFT: TOXICOLOGICAL RISK IN FLIGHT [INCENDIES A BORD DES AERONEFS: RISQUE TOXICOLOGIQUE EN VOL]** **c52**
M. Kerguelen, M. Mignet, and J. M. Jouany *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 12 p In FRENCH (For primary document see N93-19653 06-03)
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At the time of fires on board aircraft, intoxication by the products of the thermolysis of the materials used in the installation of the cabin represents a major risk. To evaluate the toxic risk of fires on board aircraft in flight, it is necessary to take into account not only the ventilation but also the pressure of the cabin, which can vary between 1000 and 750, even 700 hPa. An original model fire was developed, making it possible to study, under ventilation conditions representative of an aircraft, the influence of the pressure on the thermolysis of various materials. Thermolysis was considered on physiochemical and toxicological levels, the mouse being chosen as the experimental animal. The study showed that the toxic risk varies considerably according to the material considered. In addition, under these experimental conditions, the barometric pressure drop from 1000 to 700 hPa hardly modified the physicochemical characteristics of the thermolysis of the majority of studied materials. On the other hand this pressure drop generally generated a very significant increase in toxicity of the generated gas mixture, in which carbon monoxide and/or hydrocyanic acid have a dominant share. Author

**N93-19695#** German Air Force, Fuerstenfeldbruk (Germany). Aviation Pathology Group.
**TOXICOLOGICAL INVESTIGATIONS OF FLIGHT ACCIDENTS: FINDINGS AND METHODS** **c52**
G. Powitz *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p (For primary document see N93-19653 06-03)
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After accidents with fume in the cockpit a characteristic profile of pyrolysis products is gaschromatographically often detectable in the blood. This profile we have to distinguish from an inhalation of fuel or from a fasting blood. The sensitivity was improved. If carbonyl compounds are supposed in the biological materials, we identify them by the reaction with semicarbazide in the head space bottles of the gaschromatograph. From about 5 percent CO-Hb, we determine photometrically the cyanide level. After a fatal crash over the sea bromide-concentrations were found in the examination materials, which exceeded clearly the physiological area. All previous results with essential longer immersion-times in sea-water told against a contingent uptake of bromide from the sea. Experiments with animal and human lungs demonstrated, that we have to calculate with such an enrichment in biological materials yet. With this knowledge, a

second pilot in an analogous case could be cleared from the suspicion of having abused bromine containing sedatives, too. In estimating from a corpse, we ascertained gaschromatographically distinct higher values than with the enzymatic method. Further examinations showed that, caused by bacterial putrefaction, an alcohol formation occurred during the sample preparation. Any alcohol concentrations in the elder literature have to be regarded under a new aspect after that. In some investigations of dead pilots we identified hypnotics. In one case it succeeded to determine the time of intake with the more unspecific thin-layer chromatography instead of mass spectrometry. According to that, the extraction procedures became modified. The different used extraction methods for the single drug categories will be compared. Author

**N93-19696#** German Air Force, Fuerstenfeldbruk (Germany). Aerospace Pathology and Toxicology.

**27 YEARS ARMED FORCES AEROSPACE PATHOLOGY AND TOXICOLOGY IN THE FEDERAL REPUBLIC OF GERMANY: DEVELOPMENT, CURRENT STATUS, TRENDS AND CHALLENGES** **c52**

B. Mayr, G. Apel, and M. Kraemer *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p (For primary document see N93-19653 06-03)

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The west German armed forces Aerospace Pathology and Toxicology was founded in April 1964 as a division of the German Airforce Institute of Aerospace Medicine. Prof. S. Krefft was assigned the development of this division in a time of increasing accident rates due to the so-called 'F-104 G Starfighter crisis'. Krefft developed the concept of a mobile, airborne investigation and autopsy team with centralized laboratories for identification, histopathology and toxicology at Furstenfeldbruck AFB, near Munich. Though the doctors of the autopsy team normally are addressed as pathologists, they are in fact forensic pathologists, thereby meeting the requirements of German law. Trends in accidents and incidents are evaluated and discussed with respect to future developments. New methods and techniques are presented such as DNA-based identification. Author

**N93-19697#** German Air Force, Fuerstenfeldbruk (Germany). Aerospace Pathology and Toxicology.

**SIGNIFICANCE OF HISTOLOGICAL POSTMORTEM FINDINGS IN PILOTS KILLED IN MILITARY AND CIVIL AIRCRAFT ACCIDENTS IN GERMANY (WEST): A 25-YEAR-REVIEW** **c52**

M. Kraemer and U. Stocker *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 5 p (For primary document see N93-19653 06-03)

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The Division of Aerospace Pathology and Toxicology ('Flugunfallmedizin') at the German Air Force Aerospace Medical Institute was founded in 1964 by Col. Prof. Krefft and is since then located at Furstenfeldbruck AFB near Munich. The Division is engaged in the medical and medico-legal part of all fatal accident - most non fatal accident - and incident investigations concerning German military aircraft (Airforce, Navy and Army). The Division performs also some civilian medical accident investigations for the Federal Aviation Administration ('FUS, Flugunfall Untersuchungsstelle beim Luftfahrt Bundesamt'). The autopsy files of the period 1 January 1965 up to 31 December 1990 were reviewed. In 231 civilian and military crashes a total of 455 autopsies was performed, resulting in 385 valid autopsy reports of killed pilots including a histopathological examination. Histopathological findings were coded and stored in a data base of an IBM compatible computer. In those cases with positive histopathological findings in the files the tissue was reexamined. 36 cases showed severe histopathological alterations. 21 of these might be considered to have reduced physical and/or mental performance and thus have affected the capability of flight safety. A selection of ten cases is used to discuss problems of accident causality in case of positive histopathological findings. The value and validity of findings especially in those cases of a high degree of tissue destruction is demonstrated. In aircraft accident investigations autopsy and histopathological examination must - on the basis of nearly 5 percent positive histopathological findings - be regarded as mandatory. Author

**N93-19698#** Hellenic Air Force General Hospital, Athens (Greece).

**AIRCRAFT ACCIDENT INJURIES IN THE HELLENIC AIR FORCE IN THE LAST 20 YEARS** **c52**

Odysseas Paxinos *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)

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Military flying is a dangerous activity and safety is a major concern. Post accident pathology is an essential tool of determining the cause of death of the pilot, types of injuries, possible physiological problems that contributed to the accident and finally, possible solutions to improve safety. The aircrew injuries of 151 Class-A accidents, of the Hellenic Air Force, in the last 20 years is presented. Accidents were divided, according the aircraft type, in three groups: Jet Aircraft Accidents, Fixed Wing Props Accidents and Helicopter Accidents. In the Jet Aircraft group, a subdivision was made in three more subgroups: Non ejection attempted, successful ejection and unsuccessful ejection. In all groups the type and location of injuries was recorded, and the results were discussed. An attempt was made to give possible solutions. Injury data bank of aircraft accidents can be very useful in improving accident investigation techniques and safety and more data must be recorded. Author

**N93-19699#** Spanish Air Force, Talavera AFB. Flight Surgeon.

**AN EPIDEMIOLOGICAL STUDY IN SAF'S PILOTS EJECTIONS** **c54**

J. L. Garcia Alcon, M. R. Duran Tejeda (Extremadura Univ., Badajoz, Spain ), and J. M. Moreno Vazquez (Extremadura Univ., Badajoz, Spain ) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)

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Aircraft escape systems - the ejection seat - have saved a lot of lives, however they often have several secondary problems. First, the physical injuries directly produced by the ejection itself; and secondly, the psychological alterations caused by the fact of suffering from an aircraft accident. This study has been made to get more data on ejections raised in some Spanish Air Force pilots in order to correct the possible mistakes in further ejections. The most remarkable results are: First, the importance of performing the ejection within the safety limits of the seat, and with a very good sitting posture, to minimize possible injuries. Secondly, the necessity for both ejection seat simulator and parachute training of pilots since most injuries are generated when the pilot has a wrong sitting posture and when he lands on the ground. And finally, the quick incorporation to flying duties as soon as the ejected pilot accomplished his total recovery. Author

**N93-19700#** Army Personnel Research Establishment, Farnborough (England).

**TOWARDS AN INTEGRATED APPROACH TO PROACTIVE MONITORING AND ACCIDENT PREVENTION**

Michael H. Rejman, Colin J. Symonds (City of London Polytechnic, England ), and Eric W. Shepherd (City of London Polytechnic, England ) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 5 p (For primary document see N93-19653 06-03)

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Most traditional accident prevention programmes are based on information learned from accident research. While acknowledging the contribution from this approach, two difficulties can be identified. First, many accidents may be the product of a unique combination of circumstances. Second, the whole process is 'reactive'. In contrast, the research initiative reported here begins with the premise that the components of any organization may already hold much information which could be relevant to safety research and which could be used 'proactively'. A novel feature of the methodology outlines in this programme is that each of the areas can be considered as stand-alone models, capable of providing useful management information in their own right. Taken together, they represent a powerful and integrated approach to an organization's flight safety and accident prevention programme. I.I.C.

**N93-19701#** Army Personnel Research Establishment, Farnborough (England).

**ACCIDENTS AND ERRORS: A REVIEW OF RECENT UK ARMY AIR CORPS ACCIDENTS**

Michael H. Rejman and Colin J. Symonds (City of London Polytechnic, England ) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical

Investigation Techniques Sep. 1992 7 p (For primary document see N93-19653 06-03)
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Aircraft accidents can be categorized in a number of different ways (e.g. aircraft type, amount of damage, nature and severity of injuries sustained). Similarly, causation can be attributed to a variety of different factors (e.g. aircrew error, technical failure, operational hazard). Of all the labels used in such schemes, the one which consistently dominates the list of causes is that referred to as 'human error'. In this respect the accident statistics of the UK Army Air Corps (AAC) are no exception. However a label such as 'human error' is not particularly enlightening with regard to accident aetiology, nor does it immediately suggest obvious areas for remedial action. To satisfy these requirements, more detailed categorization schemes are necessary. Three such schemes were applied to a sample of recent AAC accidents for which human factors investigations were available. Two of the schemes had been developed within the field of aviation accident investigation while the third represented recent development within cognitive psychology. To date, around half of the accidents held in the database have been subjected to analysis. Preliminary results suggest that while all the schemes were useful, one particular scheme was easier to implement than the other two, provided a good understanding, and indicated areas for remedial action. The exercise is being extended to cover a larger sample. Author

**N93-19702#** City of London Polytechnic (England).
**PREDICTION OF SUCCESS FROM TRAINING**
Colin J. Symonds, Michael H. Rejman (Army Personnel Research Establishment, Farnborough, England ), and Eric W. Shepherd *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)
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Any training system contains information on the past and current performance of its students. However, such systems may also hold predictors capable of estimating the potential of a student. Failures that occur late during a course result in wasted costs, time and places, and also student career discontent. Therefore identifying the earliest indicators of failure is of primary importance to the operation of an efficient system. Research directed at uncovering these involves the identification of relevant behaviors; classification of the students' behaviors in real life situations; coding the classifications to form data points; and the application of analytic techniques to produce predictive models of behavior. The major emphasis of this paper is to describe attempts to define statistically derived criteria for success and failure in an existing flying training system. It is argued that the introduction of more objective techniques such as those described here may not only make the training system more efficient but may also reduce flight safety risks. Author

**N93-19703#** Naval Aerospace Medical Research Lab., Pensacola, FL. Naval Aerospace Medical Inst.
**MEDICAL EVALUATION OF SPATIAL DISORIENTATION MISHAPS c53**
A. Rupert, F. E. Guedry, and J. Clark *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 5 p (For primary document see N93-19653 06-03)
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Spatial Disorientation (SD) is a leading human-factors cause of class A mishaps in all branches of the U.S. Armed Forces. Recently, several pilots who performed well under most flight conditions were referred to the Naval Aerospace Medical Research Laboratory (NAMRL) because of inability to fly under specific conditions conducive to SD. Most had been neurologically classified as normal using the presently available clinical tests. The pilots were then referred to NAMRL for assessment of vestibular function. Some of these pilots demonstrated perceptual anomalies in attitude perception that rendered them unable to fly safely under select combinations of acceleration and visual presentations. Although U.S. Navy pilot applicants are thoroughly assessed to meet visual and auditory standards, there are no specific screening tests for vestibular function. Thus, it is possible for members of the pilot community to possess reactions that under certain conditions will render them particularly susceptible to SD. In response to requests from clinicians, we have initiated the development of a Pensacola Vestibular Test Battery (PVTB) to assess aircrew referrals. The PVTB is being used to build a normative and pathological data base that will be incorporated into mathematical models that will inform the clinicians of the perceptual consequences of vestibular anomalies in the flight environment. The same computer-based models will be useful for aircraft design, pilot selection, and mishap investigation. Author

**N93-19704#** Institute of Aviation Medicine, Oslo (Norway).
**THE NEXT GENERATION FEMALE IN COCKPIT: DO WE NEED A NEW APPROACH TO COCKPIT RESOURCE MANAGEMENT (CRM)? c54**
G. Myhre and J. E. Jansen *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p (For primary document see N93-19653 06-03)
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Several aviation accidents are caused by inadequate or misinterpreted communication within the crew or between cockpit and ATC. The present pilot training put more highlight on personality attitudes that favor crew coordination in addition to technical expertise than earlier days. This may imply that cultural differences more easily will emerge and have to be taken into training considerations instead of more or less ignoring them as was possible when the operational performance proficiency was all that really mattered for the professional pilot. With more females entering pilot training one should accept that the two sexes emerge from different training strategies, especially within crew resource management training may work more effectively than it has up till now. I.I.C.

**N93-19705#** Hopital Ambroise Pare, Boulogne-Billancourt (France).
**THE INFLUENCE OF INDIVIDUAL SENSIVITY TO STRESS ON THE BEHAVIOR (ATTITUDE AND PERFORMANCE) OF AVOIDANCE OF AN ACCIDENT [INFLUENCE DE LA SENSIBILITE INDIVIDUELLE AU STRESS SUR LE COMPORTEMENT (ATTITUDE ET PERFORMANCE) D'EVITEMENT D'ACCIDENT] c53**
Claire Petit, Alain Priez (Hopital Raymond Poincare, Garches, France ), Claude Tarriere (Centre National de la Recherche Scientifique, Lyon, France), Andre Dittmar (Centre National de la Recherche Scientifique, Lyon, France), and Evelyne Vernet-Maury *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p In FRENCH (For primary document see N93-19653 06-03)
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The Department of Environmental Sciences of RENAULT studies the behavior of a broad sample of drivers (100 people of both sexes, of all ages and all driving experiences) implied in an accidental situation (simulation of an intersection between two roads). The goal is to analyze the way in which the driver of a car uses the device for anti-locking wheels or not, not only to slow down but also to carry out a lateral offset in order to avoid the obstacle. It appears that the sensitivity of the subjects to stress, evaluated by a physiological approach during the experiments but also by psychological tests carried out before and after the experiments, explains for a considerable portion the success or failure to avoid the obstacle. Author

**N93-19706#** Concordia Univ., Montreal (Quebec). Dept of Mechanical Engineering.
**USE OF MICROPROCESSOR-BASED SIMULATOR TECHNOLOGY AND MEG/EEG MEASUREMENT TECHNIQUES IN PILOT EMERGENCY-MANOEUVER TRAINING c09**
J. V. Svoboda, Ruth M. Heron (Transportation Development Centre, Montreal, Quebec), and H. Weinberg (Simon Fraser Univ., Burnaby, British Columbia) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p (For primary document see N93-19653 06-03)
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This paper shows how a combination of microprocessor-based simulator technology and magnetoencephalographic/electroencephalographic (MEG/EEG) techniques is being used in a program of research focussing on the effectiveness of training in precision flying in order to prepare general aviation pilots for emergency situations during take-off and landing. The simulator, representative of a light twin-engine aircraft, affords safe low-cost experimentation. Evoked potentials, obtained with application of MEG/EEG techniques and interpreted within the context of an information-processing model, are expected to add significantly to information obtained from conventional measures of performance and workload. The basic procedure in the series of studies in question involves exposure of experimental groups to simulator-generated formation flying scenarios, with instructions to follow the 'lead' pilot: in subsequent test scenarios requiring

take-off and landing under engine failure and turbulent conditions, the performance of experimentals will be compared with that of controls. The paper concludes with a discussion of the safety implications of outcomes for general, military, and commercial aviation. Author

**N93-19707#** Paris V Univ. (France).
**STUDY OF THE SPECTRUM OF POWER OF CARDIAC RHYTHM DURING TASKS RELATING TO THE SAFETY OF THE CONTROL OF AN APPARATUS [ETUDE DU SPECTRE DE PUISSANCE DU RYTHME CARDIAQUE AU COURS DE TACHES RELATIVES A LA SECURITE DE LA CONDUITE DE L'APPAREIL]** **c52**

J. P. Fouillot, M. Benaoudia, P. Cabon, A. Benhalla, and A. Coblentz *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 1 p In FRENCH (For primary document see N93-19653 06-03)

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The relaxation of attention to this subject increases the probability of the occurrence of minor errors of which the absence of detection and the accumulation are likely to lead to an incident. Mulder, Vicente, Morey and other authors showed the interest of the study of the spectrum of the power of cardiac rhythm, and more particularly of the frequency band 0.05 - 0.15 Hz in the evaluation of the mental effort of the subject. We have previously shown the existence of a correspondence between measurements of cardiac variability in the temporal field, and the subjective evaluation of the workload of the pilot. This is primarily a mental workload whose main components are the pressure of time, stress and mental effort. We continued this study of the cardiac rhythm of the pilot, in the frequential field, and development of a program to analyze the power spectrum of the heart rate taking into account the limits of studying a discrete signal. The recording of the heart rate is carried out by means of an ambulatory monitoring system and is associated with synchronous observation of the activity of the subject. This method was applied to measurements carried out during psychophysiological tests in the laboratory and during real situations of the piloting of various aircraft. The results obtained show the sensitivity of the spectral energy of the cardiac rhythm in the frequency band 0.05 - 0.15 Hz, to the mental effort of the subject. However, the spectral energy in this frequency band is not correlated with the difficulty of the task, nor with the performance. Certain subjects slacken their mental effort when the difficulty of the task appears excessive to them, others maintain it or increase it without improving their performance. The increase or absence of reduction in the spectral energy of the cardiac rhythm when facing a task of increased difficulty, or during tasks relating to the safety of the piloting of the aircraft, could constitute a factor which leads to error and increases the probability of incident or accident. Author

**N93-19708#** Regie RENAULT, Nanterre (France).
**CONTRIBUTION OF THE ANALYSIS OF OCULAR ACTIVITY (COMPLEMENTARY TO THE ELECTROENCEPHALOGRAPHIC ANALYSIS) TO THE DETECTION OF LOW VIGILANCE IN INSTANCES OF PILOTING A VEHICLE [CONTRIBUTION DE L'ANALYSE DE L'ACTIVITE OCULAIRE (COMPLEMENTAIRE DE L'ANALYSE ELECTROENCEPHALOGRAPHIQUE) A LA DETECTION DES BAISSES DE VIGILANCE DANS LES TACHES DE PILOTAGE DE VEHICULE]** **c52**

C. Tarriere, S. Planque (Association pour la Recherche Interessant la Medicine du Travail, Paris, France ), C. Chabanon (Regie RENAULT, Aubevoye, France ), P. Artaud (Association pour la Recherche Interessant la Medicine du Travail, Paris, France ), and C. Lavergne (Association pour la Recherche Interessant la Medicine du Travail, Paris, France ) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p In FRENCH (For primary document see N93-19653 06-03)

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The Department of Environmental Sciences of RENAULT studies a system of detection of the drops in vigilance of the driver. Installed in the vehicle, this has as its role the prevention of any deterioration in the state of vigilance of the driver. The principle is based on the analysis in real time of the movements which the driver imposes on his wheel. The design of such a system requires, in a study phase, the knowledge at any moment of the level of vigilance of the subject from physiological signals, in order then to determine the parameters of the Flying Angle signal which will be ready to substitute itself there in order to distinguish two states of vigilance. We present here a method allowing the definition of a physiological reference of the level of vigilance of the driver, based on the approach complementary to electroencephalography (EEG), electrooculography (EOG) and on behavioral analysis by video imagery. The trend analysis of the oculographic diagrams significantly improves the early detection of hypo-vigilance. Thanks to the knowledge of this physiological reference, we now have the results obtained on the Flying Angle signal in terms of detection of hypo-vigilance. Author

**N93-19709#** Gulhane Skeri Tip Akademisi, Eskisehir (Turkey).
**GREMLINS: A DOZEN HAZARDOUS THOUGHT AND BEHAVIOR PATTERNS AS RISK FACTORS** **c53**

Muzaffer Cetinguc *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)

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The term 'Gremlins' is known as fictitious ill-tempered spirits loved by children as comic strips and movie characters. During World War 2, it was an easy and unscientific way to throw blame on Gremlins which were considered responsible for unexplainable mechanical difficulties, as if a gin caused malfunctions in the aircraft. It was the gremlin, that diagnosis of pilots and engineers for mechanical malfunctions, that caused aircraft accidents during World War 2. Today they are nothing but puppets and movie characters. Reasons of accidents are explained by more scientific methods. Although modern technology presents materials providing safety in almost all conditions, accidents continue on faults rising from human beings. In this concept, it fits more to use gremlins as 'ill-temperness belonging human psychology that may cause risk'. Some certain personality variances effect the decision and judgement functions. These disorders reflected to thinking and behavior, sometimes may be leading reasons of accidents. I.I.C.

**N93-19710#** Gulhane Skeri Tip Akademisi, Eskisehir (Turkey). Aerospace Medical Center.
**EFFECTIVENESS OF BIRTHDATE BIORHYTHM THEORY ON FLIGHT ACCIDENTS** **c52**

Muzaffer Cetinguc, Umit Sarykayalar (Gulhane Skeri Tip Akademisi, Ankara, Turkey), and Kemal Savasan (Gulhane Skeri Tip Akademisi, Ankara, Turkey) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)

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Birthdate Biorhythm Theory presents a daily guideline to people about the time of their highest and lowest performance. The theory is that it is possible to estimate in which days physical, intellectual or emotional success or failure would happen. The results reached by this investigation, in short, is that popular birthdate biorhythm theory is not capable of explaining the aircraft accidents. Ideal minimum level can be reached by objective and cautious inspections in order to decrease the accidents. The most important conditions in this is to consider the reasons and precautions from scientific perspective. It may be interesting to approach by simple method requiring scientific discussion but one must not fall in its traps. I.I.C.

**N93-19841#** General Accounting Office, Washington, DC. Resources, Community, and Economic Development Div.
**AVIATION SAFETY: PROBLEMS PERSIST IN FAA'S INSPECTION PROGRAM. REPORT TO THE CHAIRMAN, SUBCOMMITTEE ON AVIATION, COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION, HOUSE OF REPRESENTATIVES**

20 Nov. 1991 35 p

(GAO/RCED-92-14; B-245206) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

The Chairman, Subcommittee on Aviation, House Committee on Public Works and Transportation, asked us to determine whether: (1) the Federal Aviation Administration (FAA) has sufficient information to provide effective oversight of its inspection program; (2) FAA targets its inspection resources to airlines posing the greatest safety risks; and (3) FAA has a system, similar to the one developed by the Department of Defense (DOD), to assess the performance of those commercial airlines with which it contracts. These objectives also allowed us to follow-up on a central finding in our management review, Department of Transportation: Enhancing Policy and

Program Effectiveness Through Improved Management (GAO/RCED-87-3, Apr. 13, 1987), concerning the manner in which FAA allocates inspection resources. Author

**N93-19867#** Federal Aviation Administration, Washington, DC. Office of Civil Aviation Security.
**CRIMINAL ACTS AGAINST CIVIL AVIATION**
1991 90 p
(AD-A258760) Avail: CASI HC A05/MF A01

A compilation of hijackings, bombings, and other significant criminal acts against civil and general aviation interests worldwide is presented. GRA

**N93-19941#** Wichita State Univ., KS. Inst. for Aviation Research.
**CONSUMER INTEREST IN THE AIR SAFETY DATA OF THE AIRLINE QUALITY RATING. TESTIMONY TO THE US HOUSE OF REPRESENTATIVES, COMMITTEE ON GOVERNMENT OPERATIONS, GOVERNMENT ACTIVITIES AND TRANSPORTATION SUBCOMMITTEE**
Brent D. Bowen and Dean E. Headley 1 Apr. 1992 20 p
(NIAR-92-4) Avail: CASI HC A03/MF A01

The availability of aviation safety information is of vital importance to the air travel consumer. This information can provide both a positive benefit to the air travel consumer and also serve as a key element in the marketing of airline services according to Dr. Tim Becker, a noted airline consultant. At the International Forum on Airline Quality, held March 6 & 7, 1992, in Washington, D.C., Dr. Becker and others reported on the value and benefit of this information to both consumers and airlines alike. Presently, a comprehensive measure of airline safety does not exist. Research verifies that such an indicator is of significant interest to the aviation consumer. The Airline Quality Rating (AQR) is regarded as perhaps the most comprehensive measure of overall airline quality yet conceived. An explanation of these AQR factors which include data regarding airline safety is presented. Author

## 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

**N93-17954#** National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
**NARSIM AND EFMS: TOOLS FOR RESEARCH ON INTEGRATED ATM**
W. denBraven and A. L. C. vanDorp 1989 66 p Presented at Symposium on Man-Machine Interface Aspects in Civil Aviation, Delft, Netherlands, 8 Dec. 1989
(NLR-TP-89336-U; ETN-93-93318) Avail: CASI HC A04/MF A01

An overview of Air Traffic Management (ATM) research is given and the NLR Air Traffic control Research Simulator (NARSIM) and the Experimental Flight Management System (EFMS), are described. The overview of ATM research includes a general description of ATM, past ATM studies, international research programs, the NLR activities in the field of ATM, and a methodology for research in the future ATM man machine system. The description of NARSIM comprises details of present day automation in air traffic control, a functional description of NARSIM, a description of the NARSIM work environment, hardware configuration and controller workstations, and an introduction on the main research areas related to the ATM man machine system. The description of EFMS comprises an overview of the capabilities and functions of currently common flight management systems, some remarks on the pilots' general opinon on FMS usage, the EFMS project, including a description of EFMS components identified for common development, and a brief overview of the application of EFMS at the NLR. NARSIM and EFMS will enable research in most of the research areas related to the future ATM man machine system, covering both the aspects of man machine task division and man machine communication. ESA

**N93-18202#** Federal Aviation Administration, Washington, DC. Office of Airport Planning and Programming.
**REPORT TO CONGRESS: LONG-TERM AVAILABILITY OF ADEQUATE AIRPORT SYSTEM CAPACITY**
Jun. 1992 29 p
(AD-A258209; DOT/FAA/PP-92-4) Avail: CASI HC A03/MF A01

Report is submitted in accordance with Section 309 of the Airport and Airway Safety and Capacity Expansion Act of 1987, which requires the Secretary of Transportation to conduct a study for the purpose of developing an overall airport system plan through the year 2010. The report describes the probably extent of airport congestion in the future, given current trends. GRA

**N93-18309#** Naval Postgraduate School, Monterey, CA.
**AUTOMATIC PULSE SHAPING WITH THE AN/FPN-42 AND AN/FPN-44A LORAN-C TRANSMITTERS M.S. Thesis**
Dean C. Bruckner Dec. 1992 199 p
(AD-A257860) Avail: CASI HC A09/MF A03

Automatic pulse shape control is simulated for the N/FPN-42 and AN/FPN-44A tube type transmitters. A linear, time invariant (LTI) pole-zero model is developed for each transmitter at a typical operating point using the least squares modified Yule-Walker method and Shank's method. LTI models for a range of operating points are catenated to represent observed nonlinear behavior, and observed time variations are added. After these combined models are tested, a linear controller based on the method of steepest descent is implemented. These models, the control algorithm, and transmitter system details such as power supply droop, dual rating, and noise are then incorporated into a MATLAB simulation program. In a variety of realistic tests, the control algorithm successfully shaped the Loran-C pulse, except that zero-crossing times were not always in tolerance, and the algorithm showed a sensitivity to noise. The algorithm controlled Envelope-to-Cycle Difference, produced an entire Phase Code Interval of pulses while compensating for droop and phase code bounce, and produced a near-optimal transmitter drive waveform for the transmitter/antenna system using the dummy load. GRA

**N93-18873*#** Ohio Univ., Athens. Avionics Engineering Center.
**GPS INTERFEROMETRY Semiannual Progress Report, 1 Apr. - 30 Sep. 1992**
Frank vanGrass 1992 14 p
(Grant NAG1-1423)
(NASA-CR-192301; NAS 1.26:192301) Avail: CASI HC A03/MF A01

This semi-annual progress report provides an overview of the work performed during the first six months of Grant NAG 1 1423, titled 'GPS Interferometry'. The Global Positioning System (GPS) is a satellite-based positioning and timing system. Through the use of interferometric processing techniques, it is feasible to obtain sub-decimeter position accuracies for an aircraft in flight. The proposed duration of this Grant is three years. During the first year of the Grant, the efforts are focussed on two topics: (1) continued development of GPS Interferometry core technology; and (2) rapid technology demonstration of GPS interferometry through the design and implementation of a flight reference/autoland system. Multipath error has been the emphasis of the continued development of GPS Interferometry core technology. The results have been documented in a Doctoral Dissertation and a conference paper. The design and implementation of the flight reference/autoland system is nearing completion. The remainder of this progress report summarizes the architecture of this system. Author

**N93-18883*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**A PARALLEL IMPLEMENTATION OF A MULTISENSOR FEATURE-BASED RANGE-ESTIMATION METHOD**
Raymond E. Suorsa and Banavar Sridhar Jan. 1993 29 p
(RTOP 505-64-13)
(NASA-TM-103999; A-93036; NAS 1.15:103999) Avail: CASI HC A03/MF A01

There are many proposed vision based methods to perform obstacle detection and avoidance for autonomous or semi-autonomous vehicles. All methods, however, will require very high processing rates to achieve real time performance. A system capable of supporting autonomous helicopter navigation will need to extract obstacle information from imagery at rates varying from ten frames per second to thirty or more frames per second

depending on the vehicle speed. Such a system will need to sustain billions of operations per second. To reach such high processing rates using current technology, a parallel implementation of the obstacle detection/ranging method is required. This paper describes an efficient and flexible parallel implementation of a multisensor feature-based range-estimation algorithm, targeted for helicopter flight, realized on both a distributed-memory and shared-memory parallel computer. Author

**N93-18927#** Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.

**EN ROUTE AIR TRAFFIC CONTROLLERS USE OF FLIGHT PROGRESS STRIPS: A GRAPH-THEORETIC ANALYSIS Final Report**

O. U. Vortac, Mark B. Edwards, Judi P. Jones, Carol A. Manning, and A. J. Rotter Nov. 1992 18 p

(Contract DTFA02-91-C-9108)

(AD-A259062; DOT/FAA/AM-92/31) Avail: CASI HC A03/MF A01

In the United States, flight data are represented on a paper Flight Progress Strip (FPS). The role of the FPS has recently attracted attention because of plans to automate this aspect of air traffic control. The communication activities and FPS activities of air traffic controllers were categorized while they controlled air traffic of varying complexity. Transition networks were derived from the empirical transitions. These networks indicated that several aspects of air traffic control generalize across complexity, including the centrality of writing-on-the-FPS's to the control of traffic. Complexity was a factor when FPS's were used with high complexity traffic situations, requiring the controller to direct uninterrupted periods of time to the management of the FPS's rather than integrating these board management responsibilities with the responsibilities of separating aircraft. GRA

**N93-18951#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**DETECTION OF SPOOFING, JAMMING, OR FAILURE OF A GLOBAL POSITIONING SYSTEM (GPS) M.S. Thesis**

Juan R. Vasquez 4 Dec. 1992 177 p

(AD-A259023; AFIT/GE/ENG/92D-37) Avail: CASI HC A09/MF A02

The Air Force has equipped its aircraft with avionic systems such as Global Positioning System (GPS) and Inertial Guidance Systems (INS) capable of providing accurate navigation solutions. The aircrews flying these aircraft require a system that can either survive the hostile environments encountered in combat or notify the aircrew that their performance has been significantly degraded. Failure detection and isolation techniques using an extended Kalman filter and generalized likelihood ratios using matched filters are studied. Analysis is conducted using a Kalman filter development package known as the Multimode Simulation for Optimal Filter Evaluation (MSOFE). Both a large order truth model for the navigation system (in which a full 24 satellite constellation is modeled) and a reduced-order Kalman filter are developed. Results suggest that failures within the GPS can be detected, isolated, and in some cases compensated through feedback. GRA

**N93-19067#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A MODEL OF GLOBAL POSITIONING SYSTEM (GPS) MASTER CONTROL STATION (MCS) OPERATIONS M.S. Thesis**

David N. Koster 15 Dec. 1992 210 p

(AD-A258846; AFIT/GSO/ENS/92D-9) Avail: CASI HC A10/MF A03

The United States Air Force's Navstar Global Positioning System (GPS) provides high-accuracy space-based navigation and time distribution to suitably-equipped military and civilian users. The system consists of earth-orbiting satellites and a world-wide network of ground stations. A single operational control center, the GPS Master Control Station (MCS) monitors, maintains, and commands the GPS satellite constellation. The on-going deployment of the complete satellite constellation and recent changes in the operational crew structure may invalidate previously used planning and management paradigms. There is currently no analytical method for predicting the impact of these and other environmental changes on system parameters and performance. Extensive testing cannot be performed at the MCS itself due to the criticality of the GPS mission and lack of operational redundancy. A discrete event simulation model of the MCS operations center task flow, focusing on the creation and testing of a sliding-window MCS activity scheduler, is provided and validated. The simulation was validated using MCS historical data. Experiments were conducted by varying the number of ground stations and satellite constellation size available to the simulation. The results, while not quantitatively trustworthy, were used to draw general conclusions about the GPS operational environment. GRA

**N93-19078#** Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.

**CARRIER LANDING PARAMETERS FROM SURVEY 45, FLEET AND TRAINING COMMAND AIRCRAFT LANDING ABOARD USS ENTERPRISE CVN-65, MAIN TEXT AND APPENDIX A Final Report**

Richard P. Micklos 1 Dec. 1991 384 p

(AD-A258873; NADC-91124-60-App-A) Avail: CASI HC A17/MF A03

A photographic survey of landing loads, which recorded both day and night carrier landing operations, was performed aboard the USS Enterprise (CVN-65). At the time, the USS Enterprise was operating off the west coast of the United States. Over 900 day and 500 night landings of various fleet carrier aircraft were recorded and analyzed. A statistical distribution of landing parameters was generated. An additional 1000 day landings of Training Command Aircraft are included in this report. GRA

**N93-19344#** Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

**AIDS TO NAVIGATION SERVICE FORCE MIX 2000 PROJECT. VOLUME 1: DEVELOPMENT AND APPLICATION OF AN AIDS TO NAVIGATION SERVICE FORCE MIX DECISION SUPPORT SYSTEM Final Report, Jan. 1991 - Jun. 1992**

Kip Brwon, Judith Schwenk, Mark Bucciarelli, and Michael Jacobs Jul. 1992 199 p

(AD-A259065; DOT-VNTSC-CG-92-2-I-Vol-1; DOT-CG-N-01-92-1.2-Vol-1) Avail: CASI HC A09/MF A03

The Aids to Navigation (ATON) Service Force Mix (SFM) 2000 Project is documented in a Project Overview and three separately bound volumes. The Project Overview describes the purpose, approach, analysis, and results of the ATON SFM 2000 Project conducted by the USCG's Office of Navigation Safety and Waterway Services, Short Range Aids to Navigation Division. Volume 1, 'Development and Application of an Aids to Navigation Service Force Mix Decision Support System--Final Report', documents the Volpe Center's analysis and development of the proposed replacement buoy tender fleet. The document describes current ATON operations, the concept, development, and operation of the Decision Support System (DSS), the data utilized by the DSS, validation of the DSS, and the proposed service force mix. Volume 2, 'Development and Application of an Aids to Navigation Service Force Mix Decision Support System--Aid Assignments and Vessel Summary Reports', contains the DSS outputs associated with the findings of Volume 1. Included are maps of the aid assignments for each vessel in both the current and proposed fleets and the associated one-page DSS summary printouts. Volume 3, 'Analysis of Multi-Mission Requirements and Development of Planning Factors for the Replacement Buoy Tender Fleet', documents the USCG's analysis and development of baseline multimission requirements of the replacement buoy tender fleet. GRA

**N93-19386#** Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

**AIDS TO NAVIGATION SERVICE FORCE MIX 2000 PROJECT: OVERVIEW Final Report, May - Jul. 1992**

Kip Brwon and Judith Schwenk Jul. 1992 29 p

(AD-A259064; DOT-VNTSC-CG-92-2; DOT-CG-N-01-92-1.1) Avail: CASI HC A03/MF A01

The Aids to Navigation (ATON) Service Force Mix (SFM) 2000 Project is documented in a Project Overview and three separately bound volumes. The Project Overview describes the purpose, approach, analysis, and results of the ATON SFM 2000 Project conducted by the USCG's Office of Navigation Safety and Waterway Services, Short Range Aids to Navigation Division. Volume 1, 'Development and Application of an Aids to Navigation Service Force Mix Decision Support System--Final Report', documents the Volpe Center's analysis and development of the proposed replacement buoy tender fleet. Current ATON operations, the concept, development, and operation of the Decision Support System (DSS), the data utilized by the DSS, validation of the DSS, and the proposed service force mix is described. Volume 2, 'Development and Application of an Aids to Navigation

Service Force Mix Decision Support System--Aid Assignments and Vessel Summary Reports', contains the DSS outputs associated with the findings of Volume 1. Included are maps of the aid assignments for each vessel in both the current and proposed fleets and the associated one-page DSS summary printouts. Volume 3, 'Analysis of Multi-Mission Requirements and Development of Planning Factors for the Replacement Buoy Tender Fleet', documents the USCG's analysis and development of baseline multi-mission requirements of the replacement buoy tender fleet. GRA

**N93-19843#** General Accounting Office, Washington, DC. Resources, Community, and Economic Development Div.
**AVIATION SAFETY: USERS DIFFER IN VIEWS OF COLLISION AVOIDANCE SYSTEM AND CITE PROBLEMS. REPORT TO THE CHAIRMAN, SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, HOUSE OF REPRESENTATIVES**
16 Mar. 1992 19 p
(GAO/RCED-92-113; B-247195) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

The Chairman, Subcommittee on Investigations and Oversight, Committee on Science, Space, and Technology, asked us to review a number of issues related to the Traffic Alert/Collision Avoidance System (TCAS). Specifically we were asked to develop information on: (1) pilot's and air traffic controllers' view on TCAS; (2) FAA's actions to address TCAS's problems; and (3) key aspects of FAA's software engineering approach for TCAS, including FAA's plans to verify and validate the system. To obtain information on the status of TCAS's installation and reported operational problems, we reviewed relevant sections of the Federal Aviation Act of 1958, as amended, and FAA's TCAS regulations, as well as advisory circulars and various reports and position papers that provided information on TCAS operations and issues. We reviewed statistics developed by FAA's TCAS Transition Program to determine the number of altitude deviations and inappropriate TCAS advisories reported by pilots and air traffic controllers. Author

**N93-18898*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SUBNANOSECOND GPS-BASED CLOCK SYNCHRONIZATION AND PRECISION DEEP-SPACE TRACKING**
C. E. Dunn, S. M. Lichten, D. C. Jefferson, and J. S. Border *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 1-10 (For primary document see N93-18897 06-32)
(RTOP 310-10-61-90-01)
Avail: CASI HC A02/MF A03

**N93-18900*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SYSTEMS ANALYSIS FOR GROUND-BASED OPTICAL NAVIGATION**
G. W. Null, W. M. Owen, Jr., and S. P. Synnott *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 23-40 (For primary document see N93-18897 06-32)
(RTOP 310-10-63-55)
Avail: CASI HC A03/MF A03

**N93-19420*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.
**MODELING THE GLOBAL POSITIONING SYSTEM SIGNAL PROPAGATION THROUGH THE IONOSPHERE**
S. Bassiri (Sharif Univ. of Technology, Tehran, Iran ) and G. A. Hajj *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 92-103 (For primary document see N93-19413 06-32)
(RTOP 310-10-61-84-02)
Avail: CASI HC A03/MF A03

**N93-19768#** Sextant Avionique, Valence (France).
**A VISUAL OF THE HELMET FOR THE PILOTING AND THE DAY/NIGHT NAVIGATION OF THE COMBAT AIRCRAFT: REQUIREMENTS AND TECHNICAL APPROACHES [UN VISUEL DE CASQUE POUR LE PILOTAGE ET LA NAVIGATION JOUR/NUIT DES AERONEFS DE COMBAT: EXIGENCES ET APPROCHE TECHNIQUE]**
J. P. Cursolle, J. M. Kraus, and Y. Lefort *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 9 p In FRENCH (For primary document see N93-19757 06-54)
Copyright Avail: CASI HC A02/MF A03

**N93-19920#** Aerodata Flugmesstechnik G.m.b.H., Brunswick (Germany).
**HIGH PRECISION NAVIGATION FOR FLIGHT TESTING (AERONAV)**
P. Voersmann, M. Haverland, and G. Schaenzer (Technische Univ., Brunswick, Germany ) *In* AGARD, FLight Testing Oct. 1992 11 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

**N93-19924#** Test Wing (6510th), Edwards AFB, CA.
**TESTING OF AN AUTOMATIC, LOW ALTITUDE, ALL TERRAIN GROUND COLLISION AVOIDANCE SYSTEM**
M. A. Skoog and T. H. Ascough *In* AGARD, Flight Testing Oct. 1992 20 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.For land transportation vehicles see *85 Urban Technology and Transportation.*

**N93-17850#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).
**IMPROVING MILITARY TRANSPORT AIRCRAFT THROUGH HIGHLY INTEGRATED ENGINE-WING DESIGN**
A. Lardellier 1991 16 p Presented at AGARD Conference on Progress in Military Airlift
(DS-1607; ETN-93-93386) Avail: CASI HC A03/MF A01

The attraction of a 'half way approach' between turbofan (easy installation) and propfan (light thermopropulsive efficiency) concepts are considered. Results of studies which have shown the interest of very large by pass ratio engines to power long range airliners, at cruise speed exceeding Mach 0.8 are discussed, together with benefit in terms of installed specific fuel consumption, that can be expected for the Future Large Aircraft (FLA), cruising at Mach 0.75. Compared to an equivalent turbofan, a very large bypass engine can deliver a higher thrust during take off, thus improving the high lift capability of the aircraft. Taking into account that a conventional front fan engine is likely to show a large Radar Cross Section (RCS), and that this problem would have to be addressed for FLA, the engine preferred concept is a ducted aft contrafan. The resulting high hub tip ratio fan flow path, combined with slow rotating composite fan blades is indeed a good approach towards reduction of the engine RCS. In order to minimize the extra weight due to the long duct, a highly integrated engine wing design is proposed, offering a reduced friction drag; particular attention is paid to maintenance and transportation problems. ESA

**N93-17888#** Ohio State Univ., Columbus. Design Group Gray 2.
**[A MANNED HYPERSONIC RECONNAISSANCE VEHICLE WHICH DOES NOT REQUIRE AIRBORNE FUELING]**
Mike Collins, Tricia Corcoran, Timothy Higgins, Dave Kazarian, Joe Kubasek, Mike Lewis, Deanna Roll, and Chad Scherger [1992] 84 p
Avail: CASI HC A05/MF A01

This report discusses and presents a preliminary design for a manned hypersonic reconnaissance vehicle which does not require airborne refueling. This vehicle will have a range of 12000 nautical miles and will cruise at a speed of Mach 4 and an altitude of 80000 feet. The design process utilized computer programs such as HASA and MAXWARP. An elementary economic analysis is presented. Finally, areas which deserve further study are discussed. Author

**N93-17889#** Air War Coll., Maxwell AFB, AL.
**STEALTH IN THE STORM: SORTING THE FACTS FROM THE FICTION**
Ralph W. Getchell 1992 12 p
(AD-A258440) Avail: CASI HC A03/MF A01

The performance of the F-117A 'Stealth Fighter' in the Gulf War is discussed. The discussion is presented by a pilot who flew the F-117A in the Gulf War. The article is wholeheartedly supportive of stealth technology and provides some specifics relating to the F-117A's performance in the

skies over Baghdad. Two additional articles, one from a new spaper and one from a magazine, present different aspects of the issue. D.R.D.

**N93-17893#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**CFD-BASED APPROXIMATION CONCEPTS FOR AERODYNAMIC DESIGN OPTIMIZATION WITH APPLICATION TO A 2-D SCRAMJET VEHICLE Ph.D. Thesis**
Peter D. McQuade 1992 102 p
(AD-A258084; AFIT/CI/CIA-92-019D) Avail: CASI HC A06/MF A02

Approximation concepts, which are gaining popularity in structural optimization, offer the potential of providing the accuracy of a high-fidelity 'detailed' analysis model at greatly reduced computational cost. This is because the detailed model is used only to 'fine tune' a much cheaper 'approximate' model which is then used by the optimizer. The test problem is the optimization of a 2-D scramjet vehicle flying at Mach 6.0 at 30 km altitude. The objective function is net thrust. The following approximation concepts were used: Taylor series approximation to wall pressures and inlet plane flow properties; and Haftka's Global-Local Approximation (GLA) applied to the same variables. It is shown that a modification must be made to the formulation of the approximation concepts to allow for the changing CFD grids. All correction factors are applied not to the CFD grid points, but to a constant, dense, non-dimensionalized 'correction point' grid system. In flow regions devoid of shocks or other discontinuous phenomena (such as in the scramjet nozzle region), this is the only major modification needed. GRA

**N93-17958** ESDU International Ltd., London (England).
**PITCHING MOMENT OF LOW ASPECT RATIO WING-BODY COMBINATIONS UP TO HIGH ANGLES OF ATTACK AT SUPERSONIC SPEEDS**
Dec. 1992 13 p
(ESDU-92043; ISBN-0-85679-853-3) Avail: ESDU

ESDU 92043 presents a method based on evaluating the various contributions to the pitching moment, namely, those due to the body alone and the wing alone, together with interference components due to the effect of the wing on the body, the body on the wing and the body vortices on the wing. It assumes the body alone pitching moment may be combined with the products of the normal forces and centers of pressure of the wing along and interference components. The body alone pitching moment is obtained from ESDU 89014 (or the program of ESDU 90034), the wing-body mutual interference factors from ESDU 91007, and the body vortex interference factors from ESDU 91042. The wing center of pressure and normal force are evaluated following ESDU 90013 and the center of pressure of the carry-over load from the wing to the body is taken to be its aerodynamic center determined from ESDU 92024. The method applies to delta, cropped delta or rectangular thin, sharp-edged wings without camber or twist mid-set on an axisymmetric forebody-cylinder combination for Mach numbers of 1.2 to 5, taper ratios of 0 to 1, and aspect ratios of 0.2 to 4 at angles of attack up to 60 degrees. It was tested against experimental data drawn from the literature and was found to be accurate within 0.03 of body length for body fineness ratios of 10 to 20 and diameter to wing span ratios of 2.1 to 8. ESDU

**N93-17972*#** Auburn Univ., AL. Dept. of Aerospace Engineering.
**DESIGN OF THE ADVANCED REGIONAL AIRCRAFT, THE DART-75**
Steve Elliott, Jason Gislason, Mark Huffstetler, Jon Mann, Ashley Withers, and Mark Zimmerman Jun. 1992 88 p
(Contract NASw-4435)
(NASA-CR-192044; NAS 1.26:192044) Avail: CASI HC A05/MF A01

This design analysis is intended to show the capabilities of the DART-75, a 75 passenger medium-range regional transport. Included are the detailed descriptions of the structures, performance, stability and control, weight and balance, and engine design. The design should allow for the DART to become the premier regional aircraft of the future due to some advanced features like the canard, semi-composite construction, and advanced engines. Author

**N93-17974*#** California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
**MM-122: HIGH SPEED CIVIL TRANSPORT**
Bill Demarest, Kurt Anders, John Manchec, Eric Yang, Dan Overgaard, and Mike Kalkwarf Jun. 1992 107 p
(Contract NASw-4435)
(NASA-CR-192011; NAS 1.26:192011) Avail: CASI HC A06/MF A02

The rapidly expanding Pacific Rim market along with other growing markets indicates that the future market potential for a high speed civil transport is great indeed. The MM-122 is the answer to the international market desire for a state of the art, long range, high speed civil transport. It will carry 250 passengers a distance of 5200 nm at over twice the speed of sound. The MM-122 is designed to incorporate the latest technologies in the areas of control systems, propulsions, aerodynamics, and materials. The MM-122 will accomplish these goals using the following design parameters. First, a double delta wing planform with highly swept canards and an appropriately area ruled fuselage will be incorporated to accomplish desired aerodynamic characteristics. Propulsion will be provided by four low bypass variable cycle turbofan engines. A quad-redundant fly-by-wire flight control system will be incorporated to provide appropriate static stability and level 1 handling qualities. Finally, the latest in conventional metallic and modern composite materials will be used to provide desired weight and performance characteristics. The MM-122 incorporates the latest in technology and cost minimization techniques to provide a viable solution to this future market potential. Author

**N93-17976*#** California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
**PHOENIX: PRELIMINARY DESIGN OF A HIGH SPEED CIVIL TRANSPORT**
Joseph Aguilar, Steven Davis, Brian Jett, Leslie Ringo, John Stob, and Bill Wood 9 Jun. 1992 120 p
(Contract NASw-4435)
(NASA-CR-192024; NAS 1.26:192024) Avail: CASI HC A06/MF A02

The goal of the Phoenix Design Project was to develop a second generation high speed civil transport (HSCT) that will meet the needs of the traveler and airline industry beginning in the 21st century. The primary emphasis of the HSCT is to take advantage of the growing needs of the Pacific Basin and the passengers who are involved in that growth. A passenger load of 150 persons, a mission range of 5150 nautical miles, and a cruise speed of Mach 2.5 constitutes the primary design points of this HSCT. The design concept is made possible with the use of a well designed double delta wing and four mixed flow engines. Passenger comfort, compatibility with existing airport infrastructure, and cost competitive with current subsonic aircraft make the Phoenix a viable aircraft for the future. Author

**N93-17977*#** Case Western Reserve Univ., Cleveland, OH. Dept. of Mechanical and Aerospace Engineering.
**TESSERACT: SUPERSONIC BUSINESS TRANSPORT**
Eli Reshotko and Gary Garbinski 1992 74 p
(Contract NASw-4435)
(NASA-CR-192072; NAS 1.26:192072) Avail: CASI HC A04/MF A01

This year, the senior level Aerospace Design class at Case Western Reserve University developed a conceptual design of a supersonic business transport. Due to the growing trade between Asia and the United States, a transpacific range has been chosen for the aircraft. A Mach number of 2.2 was chosen too because it provides reasonable block times and allows the use of a large range of materials without a need for active cooling. A payload of 2500 lbs. has been assumed corresponding to a complement of nine (passengers and crew) plus some light cargo. With these general requirements set, the class was broken down into three groups. The aerodynamics of the aircraft were the responsibility of the first group. The second developed the propulsion system. The efforts of both the aerodynamics and propulsion groups were monitored and reviewed for weight considerations and structural feasibility by the third group. Integration of the design required considerable interaction between the groups in the final stages. The fuselage length of the final conceptual design was 107.0 ft. while the diameter of the fuselage was 7.6 ft. The delta wing design consisted of an aspect ratio of 1.9 with a wing span of 47.75 ft and midcord length of 61.0 ft. A SNEMCA MCV 99 variable-cycle engine design was chosen for this aircraft. Author

**N93-18017*#** Auburn Univ., AL. Dept. of Aerospace Engineering.
**EAGLE RTS: A DESIGN FOR A REGIONAL TRANSPORT AIRCRAFT**
Paul Bryer, Jon Buckles, Paul Lemke, and Kirk Peake 1 Jun. 1992

64 p
(Contract NASw-4435)
(NASA-CR-192032; NAS 1.26:192032) Avail: CASI HC A04/MF A01

This university design project concerns the Eagle RTS (Regional Transport System), a 66 passenger, twin turboprop aircraft with a range of 836 nautical miles. It will operate with a crew of two pilots and two flight attendents. This aircraft will employ the use of aluminum alloys and composite materials to reduce the aircraft weight and increase aerodynamic efficiency. The Eagle RTS will use narrow body aerodynamics with a canard configuration to improve performance. Leading edge technology will be used in the cockpit to improve flight handling and safety. The Eagle RTS propulsion system will consist of two turboprop engines with a total thrust of approximately 6300 pounds, 3150 pounds thrust per engine, for the cruise configuration. The engines will be mounted on the aft section of the aircraft to increase passenger safety in the event of a propeller failure. Aft mounted engines will also increase the overall efficiency of the aircraft by reducing the aircraft's drag. The Eagle RTS is projected to have a takeoff distance of approximately 4700 feet and a landing distance of 6100 feet. These distances will allow the Eagle RTS to land at the relatively short runways of regional airports. Author

**N93-18037*#** Ohio State Univ., Cleveland. Dept. of Aeronautical and Astronautical Engineering.
**ADVANCED HYPERSONIC AIRCRAFT DESIGN**
Rob Utzinger, Hans-Joachim Blank, Craig Cox, Greg Harvey, Mike McKee, Dave Molnar, Greg Nagy, and Steve Petersen 1 Jun. 1992 87 p
Sponsored by NASA. Lewis Research Center and GE
(NASA-CR-192046; NAS 1.26:192046) Avail: CASI HC A05/MF A01

The objective of this design project is to develop the hypersonic reconnaissance aircraft to replace the SR-71 and to complement existing intelligence gathering devices. The initial design considerations were to create a manned vehicle which could complete its mission with at least two airborne refuelings. The aircraft must travel between Mach 4 and Mach 7 at an altitude of 80,000 feet for a maximum range of 12,000 nautical miles. The vehicle should have an air breathing propulsion system at cruise. With a crew of two, the aircraft should be able to take off and land on a 10,000 foot runway, and the yearly operational costs were not to exceed $300 million. Finally, the aircraft should exhibit stealth characteristics, including a minimized radar cross-section (RCS) and a reduced sonic boom. The technology used in this vehicle should allow for production between the years 1993 and 1995. Author

**N93-18042** ESDU International Ltd., London (England).
**ENERGY METHOD FOR ANALYSIS OF MEASURED AIRSPEED CHANGE IN LANDING AIRBORNE MANOEUVRE**
Dec. 1992 21 p
(ESDU-92020; ISBN-0-85679-825-8) Avail: ESDU

ESDU 92020 gives a method that correlates measurements of airspeed changed in the airborne maneuver on the basis of energy considerations to yield changes in lift and in drag-minus-thrust between screen and touchdown. The method applies to fixed wing aircraft and can be applied to any set of flight test measurements although it is most effective when the landings have a common 'style'. Examples would be those flown for civil certification purposes, or those representative of operational practice. The use of the correlation to calculate touchdown speed from a knowledge of the airborne time and the screen speed is explained, and methods of calculating the airborne time are suggested. The prediction of the airborne distance from the speeds and airborne time is straightforward in still air, but the effect of a steady wind, and a wind gradient, is considered. A worked example illustrates the use of the method, and the scatter on some points is investigated in relation to the 'style'. Examples of the application of the method to particular sets of test data are shown for jet-, fan- and propeller-driven civil and military aeroplanes and to an unpowered aircraft. They contain large ranges of approach angle, speed, power-cut height and landing 'style'. ESDU

**N93-18049*#** California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
**PROPOSAL AND PRELIMINARY DESIGN FOR A HIGH SPEED CIVIL TRANSPORT AIRCRAFT. SWIFT: A HIGH SPEED CIVIL TRANSPORT FOR THE YEAR 2000**
Aerobel Banuelos, Maria L. Caballero, Richard S. Fields, Jr., Martha E. Ledesma, Lynne A. Murakami, Joe T. Reyes, and Bryan W. Westra 9 Jun. 1992 103 p
(Contract NASw-4435)
(NASA-CR-192023; NAS 1.26:192023) Avail: CASI HC A06/MF A02

To meet the needs of the growing passenger traffic market in light of an aging subsonic fleet, a new breed of aircraft must be developed. The Swift is an aircraft that will economically meet these needs by the year 2000. Swift is a 246 passenger, Mach 2.5, luxury airliner. It has been designed to provide the benefit of comfortable, high speed transportation in a safe manner with minimal environmental impact. This report will discuss the features of the Swift aircraft and establish a solid, foundation for this supersonic transport of tomorrow. Author

**N93-18054*#** California Polytechnic State Univ., San Luis Obispo. Senior Design Team.
**TBD(EXP 3)**
Jim Baughan, David Calta, Victor Cross, Mozhi Habashi, Donovan Mathias, and Patti Northrup 1992 100 p
(Contract NASw-4435)
(NASA-CR-192075; NAS 1.26:192075) Avail: CASI HC A05/MF A02

When asked by the Aeronautical Engineering staff to design a viable supersonic commercial transport, most of the students were well aware that Boeing, McDonnell Douglas, and other aircraft companies had been studying a cadre of transports for more than 30 years and had yet to present a viable aircraft. In the spirit of aviation progress and with much creative license, the TBD design team spearheaded the problem with the full intention of presenting a marketable high speed civil transport in spring of 1992. The project commenced with various studies of future market demands. With the market expansion of American business overseas, the airline industry projects a boom of over 200 million passengers by the year 2000. This will create a much higher demand for time efficient and cost effective inter-continental travel; this is the challenge of the high speed civil transport. The TBD(exp 3), a 269 passenger, long-range civil transport was designed to cruise at Mach 3.0 utilizing technology predicted to be available in 2005. Unlike other contemporary commercial airplane designs, the TBD(exp 3) incorporates a variable geometry wing for optimum performance. This design characteristic enabled the TBD(exp 3) to be efficient in both subsonic and supersonic flight. The TBD(exp 3) was designed to be economically viable for commercial airline purchase, be comfortable for passengers, meet FAR Part 25, and the current FAR 36 Stage 3 noise requirements. The TBD(exp 3) was designed to exhibit a long service life, maximize safety, ease of maintenance, as well as be fully compatible with all current high-traffic density airport facilities. Author

**N93-18055*#** California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
**THE EDGE SUPERSONIC TRANSPORT Preliminary Design Report**
Roxana Agosta, Dushan Bilbija, Marc Deutsch, David Gallant, Don Rose, Gene Shreve, David Smario, and Brian Suffredini 1992 126 p
(Contract NASw-4435)
(NASA-CR-192074; NAS 1.26:192074) Avail: CASI HC A07/MF A02

As intercontinental business and tourism volumes continue their rapid expansion, the need to reduce travel times becomes increasingly acute. The Edge Supersonic Transport Aircraft is designed to meet this demand by the year 2015. With a maximum range of 5750 nm, a payload of 294 passengers and a cruising speed of M = 2.4, The Edge will cut current international flight durations in half, while maintaining competitive first class, business class, and economy class comfort levels. Moreover, this transport will render a minimal impact upon the environment, and will meet all Federal Aviation Administration Part 36, Stage III noise requirements. The cornerstone of The Edge's superior flight performance is its aerodynamically efficient, dual-configuration design incorporating variable-geometry wingtips. This arrangement combines the benefits of a high aspect ratio wing at takeoff and low cruising speeds with the high performance of an arrow-wing in supersonic cruise. And while the structural weight concerns relating to swinging wingtips are substantial, The Edge looks to ever-advancing material technologies to further increase its viability. Heeding well the lessons of the past, The Edge design holds economic feasibility as its primary focus. Therefore, in addition to its inherently superior aerodynamic performance, The Edge uses a lightweight, largely windowless configuration, relying on a synthetic vision system for outside viewing by both pilot and passengers. Additionally, a fly-by-light flight control system is incorporated to address

aircraft supersonic cruise instability. The Edge will be produced at an estimated volume of 400 aircraft and will be offered to airlines in 2015 at $167 million per transport (1992 dollars). Author

**N93-18056*#** Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.

**HERMES CX-7: AIR TRANSPORT SYSTEM DESIGN SIMULATION Final Design Proposal**

Brian Amer, John Barter, Jay Colucci, Caryn Foley, James Kockler, David Rapp, and Matthew Zeiger May 1992 121 p Sponsored in cooperation with Boeing Commercial Airplane Co.

(Contract NASw-4435)

(NASA-CR-192082; NAS 1.26:192082) Avail: CASI HC A06/MF A02

The Hermes CX-7 has been designed to service the overnight parcel package delivery needs of the cities of Aeroworld as determined in the G-Dome Enterprises market survey. The design optimization centers on the prime goal of servicing the needs of these cities as efficiently and profitably as possible. The greatest factors which affect the design of an aircraft for the mission outlined in the Request for Proposal are cost, construction feasibility and effectiveness of the design. Other influencing factors are given by the constraints of the market, including a maximum takeoff and landing distance of 60 feet, storage capability in a container of size 5 ft. x 3 ft. x 2 ft., cargo packages of 2 inch and 4 inch cubes, and ability to turn with a radius no larger than 60 feet. Safety considerations such as flying at or below Mach one (30 ft/s) and controllability and maintainability of the aircraft must also be designed into the aircraft. Another influential factor is the efficiency of the aircraft which involves optimizations and tradeoffs of such factors as weight, lifting surface sizing, structural redundancy, and material costs. Author

**N93-18059*#** California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.

**A SECOND-GENERATION HIGH SPEED CIVIL TRANSPORT: STINGRAY**

Sean Engdahl, Kevin Lopes, Angelen Ngan, Joseph Perrin, Marcus Phipps, Blake Westman, and Urn Yeo 1992 116 p

(Contract NASw-4435)

(NASA-CR-192022; NAS 1.26:192022) Avail: CASI HC A06/MF A02

The Stingray is the second-generation High Speed Civil Transport (HSCT) designed for the 21st Century. This aircraft is designed to be economically viable and environmentally sound transportation competitive in markets currently dominated by subsonic aircraft such as the Boeing 747 and upcoming McDonnell Douglas MD-12. With the Stringray coming into service in 2005, a ticket price of 21 percent over current subsonic airlines will cover operational costs with a 10 percent return on investment. The cost per aircraft will be $202 million with the Direct Operating Cost equal to $0.072 per mile per seat. This aircraft has been designed to be a realistic aircraft that can be built within the next ten to fifteen years. There was only one main technological improvement factor used in the design, that being for the engine specific fuel consumption. The Stingray, therefore, does not rely on technology that does not exist. The Stingray will be powered by four mixed flow turbofans that meet both nitrous oxide emissions and FAR 36 Stage 3 noise regulations. It will carry 250 passengers a distance of 5200 nautical miles at a speed of Mach 2.4. The shape of the Stingray, while optimized for supersonic flight, is compatible with all current airline facilities in airports around the world. As the demand for economical, high-speed flight increases, the Stingray will be ready and able to meet those demands. Author

**N93-18060*#** California Polytechnic State Univ., San Luis Obispo. Cones of Silence Design Group.

**THE TROJAN**

1992 120 p

(Contract NASw-4435)

(NASA-CR-192013; NAS 1.26:192013) Avail: CASI HC A06/MF A02

The Trojan is the culmination of thousands of engineering person-hours by the Cones of Silence Design Team. The goal was to design an economically and technologically viable supersonic transport. The Trojan is the embodiment of the latest engineering tools and technology necessary for such an advanced aircraft. The efficient design of the Trojan allows for supersonic cruise of Mach 2.0 for 5,200 nautical miles, carrying 250 passengers. The per aircraft price is placed at $200 million, making the Trojan a very realistic solution for tomorrows transportation needs. The following is a detailed study of the driving factors that determined the Trojan's super design. Author

**N93-18061*#** California Polytechnic State Univ., San Luis Obispo. Opus 0-001 Design Team.

**PRELIMINARY DESIGN OF A HIGH SPEED CIVIL TRANSPORT: THE OPUS 0-001**

[1992] 103 p

(Contract NASw-4435)

(NASA-CR-192018; NAS 1.26:192018) Avail: CASI HC A06/MF A02

Based on research into the technology and issues surrounding the design, development, and operation of a second generation High Speed Civil Transport, HSCT, the Opus 0-001 team completed the preliminary design of a sixty passenger, three engine aircraft. The design of this aircraft was performed using a computer program which the team wrote. This program automatically computed the geometric, aerodynamic, and performance characteristic of an aircraft whose preliminary geometry was specified. The Opus 0-001 aircraft was designed for a cruise Mach number of 2.2, a range of 4,700 nautical miles and its design was based in current or very near term technology. Its small size was a consequence of an emphasis on a profitable, low cost program, capable of delivering tomorrow's passengers in style and comfort at prices that make it an attractive competitor to both current and future subsonic transport aircraft. Several hundred thousand cases of Cruise Mach number, aircraft size and cost breakdown were investigated to obtain costs and revenues for which profit was calculated. The projected unit flyaway cost was $92.0 million per aircraft. Author

**N93-18063*#** Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.

**ARROW 227: AIR TRANSPORT SYSTEM DESIGN SIMULATION Final Design Proposal**

Michael Bontempi, Dave Bose, Georgeann Brophy, Timothy Cashin, Michael Kanarios, Steve Ryan, and Timothy Peterson May 1992 118 p Sponsored in cooperation with Boeing Commercial Airplane Co.

(Contract NASw-4435)

(NASA-CR-192053; NAS 1.26:192053) Avail: CASI HC A06/MF A02

The Arrow 227 is a student-designed commercial transport for use in a overnight package delivery network. The major goal of the concept was to provide the delivery service with the greatest potential return on investment. The design objectives of the Arrow 227 were based on three parameters; production cost, payload weight, and aerodynamic efficiency. Low production cost helps to reduce initial investment. Increased payload weight allows for a decrease in flight cycles and, therefore, less fuel consumption than an aircraft carrying less payload weight and requiring more flight cycles. In addition, fewer flight cycles will allow a fleet to last longer. Finally, increased aerodynamic efficiency in the form of high L/D will decrease fuel consumption. Author

**N93-18064*#** Arizona State Univ., Tempe.

**OPTIMUM DESIGN OF HIGH SPEED PROP-ROTORS**

Aditi Chattopadhyay 12 Oct. 1992 34 p

(Grant NAG2-771)

(NASA-CR-190915; NAS 1.26:190915) Avail: CASI HC A03/MF A01

The objective of this research is to develop optimization procedures to provide design trends in high speed prop-rotors. The necessary disciplinary couplings are all considered within a closed loop optimization process. The procedures involve the consideration of blade aeroelastic, aerodynamic performance, structural and dynamic design requirements. Further, since the design involves consideration of several different objectives, multiobjective function formulation techniques are developed. For individual titles, see N93-18065 through N93-18066.

**N93-18065*#** Arizona State Univ., Tempe. Dept. of Aerospace and Mechanical Engineering.

**DESIGN OF HIGH SPEED PROPROTORS USING MULTIOBJECTIVE OPTIMIZATION TECHNIQUES**

Thomas R. McCarthy and Aditi Chattopadhyay *In its* Optimum Design of High Speed Prop-Rotors 17p (SEE N93-18064 06-05) 12 Oct. 1992

(For primary document see N93-18064 06-05)

(Grant NAG2-771)
Avail: CASI HC A03/MF A01

An integrated, multiobjective optimization procedure is developed for the design of high speed proprotors with the coupling of aerodynamic, dynamic, aeroelastic, and structural criteria. The objectives are to maximize propulsive efficiency in high speed cruise and rotor figure of merit in hover. Constraints are imposed on rotor blade aeroelastic stability in cruise and on total blade weight. Two different multiobjective formulation procedures, the Min summation of beta and the K-S function approaches are used to formulate the two-objective optimization problems. Author

**N93-18066*#** Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.

**OPTIMUM DESIGN OF HIGH SPEED PROP ROTORS INCLUDING THE COUPLING OF PERFORMANCE, AEROELASTIC STABILITY AND STRUCTURES**

Aditi Chattopadhyay, Thomas R. McCarthy, and John F. Madden, III (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) *In its* Optimum Design of High Speed Prop-Rotors 12 Oct. 1992 13 p (For primary document see N93-18064 06-05)
(Grant NAG2-771)
Avail: CASI HC A03/MF A01

An optimization procedure is developed for the design of high speed prop-rotors to be used in civil tiltrotor applications. The goal is to couple aerodynamic performance, aeroelastic stability, and structural design requirements inside a closed-loop optimization procedure. The objective is to minimize the gross weight and maximize the propulsive efficiency in high speed cruise. Constraints are imposed on the rotor aeroelastic stability in both hover and cruise and rotor figure of merit in hover. Both structural and aerodynamic design variables are used. Author

**N93-18131#** Manchester Univ. (England). Aeronautical Engineering Group.

**AIRCRAFT TURNS INTO AND DOWN WIND**

A. W. Bloy and K. A. Lea 18 Feb. 1992 13 p
(Aero-Rept-9201; ETN-93-93002) Avail: CASI HC A03/MF A01

An explanation of the effects of airspeed on an aircraft when tuning into or down wind is presented. By considering two reference frames, one fixed to the ground and one moving with the wind, it was shown that the airspeed of an aircraft in a banked turn without sideslip is unaffected by the wind or direction. The forces acting on the aircraft are the same with or without wind so that the pilot experiences the same acceleration and applies the same control movements. The flight path relative to the wind remains circular as in still air but is distorted relative to the ground. The aircraft ground speed increases in a turn downwind and decreases in a turn upwind, while airspeed remains constant. In terms of airspeed there is therefore no advantage in performing a quick turn into wind. ESA

**N93-18155*#** Ohio State Univ., Columbus. Dept. of Aerospace.

**SR-SCARLET 1: PEREGRIN**

Manoj Tandon, Joseph C. Zuppardo, James Johnson, Mike Kilian, Norman Schacht, Diane Flowers, Greg Zorn, and Chad Brown 26 Jan. 1993 112 p
(Contract NASw-4435)
(NASA-CR-192048; NAS 1.26:192048) Avail: CASI HC A06/MF A02

This report presents a reconnaissance aircraft with a lifting body configuration. The aircraft is capable of flying a distance of 6000 nmi at Mach 5 with a payload of 7500 pounds. The aircraft does not require a runway for takeoff for it is air launched from a carrier aircraft. Specifically this report addresses the areas of external aerodynamics, cost, thermal protection systems, propulsion, stability and control, and materials. Each area is represented by a separate section. This allows for selective reading. Author

**N93-18161*#** California State Polytechnic Univ., Pomona. Dept. of Aerospace Engineering.

**HIGH SPEED CIVIL TRANSPORT**

1991 108 p
(Contract NASw-4435)
(NASA-CR-192041; NAS 1.26:192041) Avail: CASI HC A06/MF A02

This report discusses the design and marketability of a next generation supersonic transport. Apogee Aeronautics Corporation has designated its High Speed Civil Transport (HSCT): Supercruiser HS-8. Since the beginning of the Concorde era, the general consensus has been that the proper time for the introduction of a next generation Supersonic Transport (SST) would depend upon the technical advances made in the areas of propulsion (reduction in emissions) and material composites (stronger, lighter materials). It is believed by many in the aerospace industry that these beforementioned technical advances lie on the horizon. With this being the case, this is the proper time to begin the design phase for the next generation HSCT. The design objective for a HSCT was to develop an aircraft that would be capable of transporting at least 250 passengers with baggage at a distance of 5500 nmi. The supersonic Mach number is currently unspecified. In addition, the design had to be marketable, cost effective, and certifiable. To achieve this goal, technical advances in the current SST's must be made, especially in the areas of aerodynamics and propulsion. As a result of these required aerodynamic advances, several different supersonic design concepts were reviewed. Author

**N93-18166*#** California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.

**RTJ-303: VARIABLE GEOMETRY, OBLIQUE WING SUPERSONIC AIRCRAFT**

Albert Antaran, Hailu Belete, Mark Dryzmkowski, James Higgins, Alan Klenk, and Lisa Rienecker 29 May 1992 92 p
(Contract NASw-4435)
(NASA-CR-192054; NAS 1.26:192054) Avail: CASI HC A05/MF A01

This document is a preliminary design of a High Speed Civil Transport (HSCT) named the RTJ-303. It is a 300 passenger, Mach 1.6 transport with a range of 5000 nautical miles. It features four mixed-flow turbofan engines, variable geometry oblique wing, with conventional tail-aft control surfaces. The preliminary cost analysis for a production of 300 aircraft shows that flyaway cost would be 183 million dollars (1992) per aircraft. The aircraft uses standard jet fuel and requires no special materials to handle aerodynamic heating in flight because the stagnation temperatures are approximately 130 degrees Fahrenheit in the supersonic cruise condition. It should be stressed that this aircraft could be built with today's technology and does not rely on vague and uncertain assumptions of technology advances. Included in this report are sections discussing the details of the preliminary design sequence including the mission to be performed, operational and performance constraints, the aircraft configuration and the tradeoffs of the final choice, wing design, a detailed fuselage design, empennage design, sizing of tail geometry, and selection of control surfaces, a discussion on propulsion system/inlet choice and their position on the aircraft, landing gear design including a look at tire selection, tip-over criterion, pavement loading, and retraction kinematics, structures design including load determination, and materials selection, aircraft performance, a look at stability and handling qualities, systems layout including location of key components, operations requirements maintenance characteristics, a preliminary cost analysis, and conclusions made regarding the design, and recommendations for further study. Author

**N93-18248#** Wright Lab., Wright-Patterson AFB, OH.

**ADD-ON DAMPING TREATMENT FOR THE F-15 UPPER-OUTER WING SKIN Final Report, Jan. 1989 - Feb. 1991**

Vincent Levraea, Lynn Rogers, Arnel Pacia, and Mike Parin 26 Mar. 1992 129 p
(AF Proj. 2401)
(AD-A258470; WL-TR-92-3069) Avail: CASI HC A07/MF A02

The purpose of this investigation was to design, fabricate, and verify candidate add-on damping treatments for the F-15 upper-outer wing skin. The F-15 upper-outer wing skin has experienced high cycle fatigue cracks caused by separated flow on the upper wing surface. The separated flow results during high load factor maneuvers, and in turn induces large vibratory loads on the upper wing skin and associated substructure. The capability of the F-15 to sustain these maneuvers allows the excitation to occur for sufficiently long periods of time to result in damage. Damage accumulates due to the resonant vibration of local skin/stiffener modes. The cracks initiate at the fastener holes adjacent to the integrally machined 'T' stiffeners and tend to propagate parallel to the stiffeners. Two damping treatments resulted from the investigation and were recommended for F-15 fleet retrofit. One was an external constrained-layer treatment and the other was an internal 'stand-off' treatment. Laboratory vibration, corrosion, and thermal

aging tests were conducted as part of the development of the add-on damping treatments. Estimates of the life extension factors for the external and internal damping treatments were 5 and 34 respectively. GRA

**N93-18257#** Aeronautical Research Labs., Melbourne (Australia).
**DAMAGE TOLERANCE ASSESSMENT OF BORON/EPOXY REPAIRS TO FUSELAGE LAP JOINTS**
D. Rees, L. Molent, and R. Jones Aug. 1992 27 p
(AD-A258383; ARL-STRUC-R-449; DODA-AR-007-103) Avail: CASI HC A03/MF A01

This report describes an experimental program into the damage tolerance of boron/epoxy repairs to multi-site damage in a typical aircraft fuselage lap joint. Repaired lap joint specimens containing adhesive disbonds and impact damage were evaluated using both fatigue and static tension tests. It was demonstrated that such damage had no significant effect on the performance of the repairs. GRA

**N93-18304#** Naval Postgraduate School, Monterey, CA.
**RPH PRELIMINARY DESIGN, TREND ANALYSIS AND INITIAL ANALYSIS OF THE NPS HUMMINGBIRD M.S. Thesis**
James L. Vandiver 24 Sep. 1992 104 p
(AD-A257854) Avail: CASI HC A06/MF A02

The Department of Aeronautics and Astronautics at the Naval Postgraduate School (NPS) is expanding its helicopter research capabilities in order to facilitate present and future research demands. The rapidly changing needs have already outpaced available assets. Therefore, it's necessary to design and develop a new remotely piloted helicopter (RPH) that would meet present needs, NOTAR and HHC, and be flexible enough to meet future needs. The research efforts encompassed by this thesis are defining the present needs, investigating what type/size of RPH would fulfill these needs, procuring this asset, and analyzing its capabilities. Based on a defined payload, helicopter trends are analyzed to determine an estimate of the overall RPH size (gross weight) and engine size required. A preliminary design process validates these figures. Choosing to procure an RPH instead of building one, a detailed performance analysis is conducted on the main rotor system. This analysis includes blade vibration analysis, retreating blade stall analysis, and power required analysis. Modification of the RPH's main rotor hub, drive train, and landing gear are studied and recommendations presented. This research effort is a continuation of a long-term program to provide NPS with robust assets to support present and future rotorcraft research efforts. GRA

**N93-18333*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**TRADE-OFFS ARISING FROM MIXTURE OF COLOR CUEING AND MONOCULAR, BINOPTIC, AND STEREOSCOPIC CUEING INFORMATION FOR SIMULATED ROTORCRAFT FLIGHT**
Russell V. Parrish and Steven P. Williams Feb. 1993 81 p
(DA Proj. 1L1-61102-AH-45; RTOP 505-64-13-32)
(NASA-TP-3268; L-17085; NAS 1.60:3268; CECOM-TR-92-B-014) Avail: CASI HC A05/MF A01

To provide stereopsis, binocular helmet-mounted display (HMD) systems must trade some of the total field of view available from their two monocular fields to obtain a partial overlap region. The visual field then provides a mixture of cues, with monocular regions on both peripheries and a binoptic (the same image in both eyes) region or, if lateral disparity is introduced to produce two images, a stereoscopic region in the overlapped center. This paper reports on in-simulator assessment of the trade-offs arising from the mixture of color cueing and monocular, binoptic, and stereoscopic cueing information in peripheral monitoring displays as utilized in HMD systems. The accompanying effect of stereoscopic cueing in the tracking information in the central region of the display is also assessed. The pilot's task for the study was to fly at a prescribed height above an undulating pathway in the sky while monitoring a dynamic bar chart displayed in the periphery of their field of view. Control of the simulated rotorcraft was limited to the longitudinal and vertical degrees of freedom to ensure the lateral separation of the viewing conditions of the concurrent tasks. Author

**N93-18339#** Naval Postgraduate School, Monterey, CA.
**AN INVESTIGATION OF A PROTOTYPE OASYS EFFECTIVENESS IN MANEUVERING FLIGHT M.S. Thesis**
Christopher C. Sullivan Sep. 1992 156 p
(AD-A257901) Avail: CASI HC A08/MF A02

An analysis of the current Northrop helicopter obstacle avoidance system (OASYS) prototype with a fixed forward mounting, 25 x 50 degree field of view, 860 nanometer wavelength LADAR, was conducted to determine system effectiveness during simulated aircraft level accelerations ranging from 0 to 100 knots, and at acceleration rates of from 0 to 2.9 meters/sec(exp 2). Computer simulation flights were conducted using flight parameter data recorded at the Army Aero-flight-dynamics Directorate Crew Station Research and Development Facility's (CSRDF) advanced concepts flight simulator. A multiple-program computer simulation was used to model the helicopter and sensor dynamics over a tactical data base of numerous obstacles consisting of trees, wires, and poles; the resulting window of safety (WOS) displays were analyzed by comparing each acceleration maneuver with a control maneuver in which the sensor was horizon stabilized. A mathematical model of the flight maneuvers for which the OASYS prototype operated effectively was then determined based on the results of these simulations. The limits of this analytical flight envelope were then verified experimentally via a series of computer simulations using generalized maneuvers conducted over a standardized obstacle data base. GRA

**N93-18349*#** Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
**THE S.T.O.R.M. (TM): AIR TRANSPORT SYSTEM DESIGN SIMULATION Final Design Proposal**
May 1992 115 p Sponsored in cooperation with Boeing Commercial Airplane Co.
(Contract NASw-4435)
(NASA-CR-192070; NAS 1.26:192070) Avail: CASI HC A06/MF A02

The members of Team Asylum have proposed a helicopter design concept, called the S.T.o.R.M., in order to meet the market demands for an aircraft to perform overnight package delivery services in Aeroworld. The helicopter concept was chosen over a fixed wing aircraft design to fulfill the mission requirements for a variety of reasons, all of which will be discussed later. However, many critical design areas needed to be investigated as part of the helicopter concept's selection. One of the most significant design factors was the weight of the aircraft. This determined the selection of the propulsion system necessary to get the S.T.o.R.M. off the ground, and maintain flight once airborne. Another significant factor that went hand in hand with the motor selection was the choice of the main rotor. Since the main rotor is the primary source of lift for the helicopter, its proper selection became increasingly important. Author

**N93-18350*#** Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
**JEFF: AIR TRANSPORT SYSTEM DESIGN SIMULATION Final Design Proposal**
May 1992 116 p Sponsored in cooperation with Boeing Commercial Airplane Co.
(Contract NASw-4435)
(NASA-CR-192069; NAS 1.26:192069) Avail: CASI HC A06/MF A02

Jeff is a remotely piloted vehicle designed by the Blue Team, a division of AE441, Inc., to fulfill the mission proposed by G-Dome Enterprises: to build a cost efficient aircraft to service Aeroworld with overnight cargo delivery. The design of Jeff was most significantly influenced by the need to minimize costs. This objective was pursued by building fewer large planes as opposed to many small planes. Thus, by building an aircraft with a large payload capacity, G-Dome Enterprises will be able to minimize the large costs and the large number of cycles that are associated with a large fleet. Another factor which had a significant influence on our design was the constraint that our design had to fit into a 2'x2'x5' storage container. This constraint meant that unless we wanted to build foldable wings that Jeff's span would be limited to 10 feet. Since this was not enough lifting surface to suit our needs a canard configuration was chosen to get the needed lifting surface and avoid the structural dilemma of foldable wings. The aircraft is constructed mainly of balsa, with spruce wing and canard spars and a monokote covering. It was designed to support a maximum payload weight of 35 oz. (total aircraft weight of 108 oz.) and withstand a maximum load factor of 2.5. I.I.C.

**N93-18386*#** Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.

**THE F-92 RELIANT: AIR TRANSPORT SYSTEM DESIGN SIMULATION Final Design Proposal**

May 1992 175 p Sponsored in cooperation with Boeing Commercial Airplane Co.

(Contract NASw-4435)

(NASA-CR-192050; NAS 1.26:192050) Avail: CASI HC A08/MF A02

The design proposal of a semester long design project by group 'F' for AE 441 is addressed. In formulating this design, the driving philosophy was not just to fulfill the mission requirements (discussed in chapter two), but to do so in a creative manner - this explains the unconventional aircraft design, named the F-92 RELIANT. Although unconventional, and perhaps more expensive to produce, the design has distinct advantages which could only be attained through such a creative design. Major components of the F-92 Reliant include: (1) unobstructed cargo bay, 1024 cu. in. capability; (2) loading ramp; (3) dual wing configuration; and (4) polyhedral wing configuration. These design components either originated or evolved to create an aircraft that would most effectively meet the goals of cargo transportation in AeroWorld at minimum cost. Author

**N93-18396*#** Arizona State Univ., Tempe. Coll. of Engineering and Applied Sciences.

**DYNAMICS OF AEROSPACE VEHICLES Final Technical Report, 1 Jan. 1990 - 3 Jan. 1991**

David K. Schmidt 1 Sep. 1991 59 p

(Grant NAG1-1086)

(NASA-CR-192179; NAS 1.26:192179) Avail: CASI HC A04/MF A01

The focus of this research was to address the modeling, including model reduction, of flexible aerospace vehicles, with special emphasis on models used in dynamic analysis and/or guidance and control system design. In the modeling, it is critical that the key aspects of the system being modeled be captured in the model. In this work, therefore, aspects of the vehicle dynamics critical to control design were important. In this regard, fundamental contributions were made in the areas of stability robustness analysis techniques, model reduction techniques, and literal approximations for key dynamic characteristics of flexible vehicles. All these areas are related. In the development of a model, approximations are always involved, so control systems designed using these models must be robust against uncertainties in these models. Author

**N93-18451#** Naval Postgraduate School, Monterey, CA.

**STUDY OF STATISTICAL VARIATIONS OF LOAD SPECTRA AND MATERIAL PROPERTIES ON AIRCRAFT FATIGUE LIFE M.S. Thesis**

Richard W. Walter, II Sep. 1992 84 p

(AD-A257961) Avail: CASI HC A05/MF A01

NAVAIR utilizes the fatigue spectrum of an existing Navy aircraft to set the structural design requirements for a new Navy aircraft. The current design requirement is for the new aircraft to withstand a fatigue spectrum at least as severe as the spectrum experienced by 99.73 percent (3 standard deviations) of the aircraft from which the design requirement originated. Two years of A-6 data were used in the study, which contained the number of g exceedences at the four g, five g, six g, and seven g levels. Trade off studies were completed to analytically examine the variation in the fatigue life of an aircraft while varying the reference stress at the notch of a crack, re-ordering of the load sequences within the spectrum, varying the 3 sigma design requirement, and changing the material properties of the metal. The results indicated that NAVAIR's current requirement for a new aircraft to withstand a three sigma spectrum may be too severe. This conclusion is only valid for a three sigma spectrum based on the A-6 load history. GRA

**N93-18507#** Sheffield Univ. (England). Dept. of Control Engineering.

**IDENTIFICATION OF SYSTEM DYNAMICS OF A HIGH INCIDENCE RESEARCH MODEL**

G. N. Jones and S. A. Billings 1 Oct. 1990 13 p

(RR-407; ETN-92-92766) Avail: CASI HC A03/MF A01

The application of orthogonal nonlinear multivariable identification techniques to model the flight dynamics of a high incidence research model is presented. The system model derived is then shown to be a valid representation of the true system dynamics. The aim of the work is to demonstrate the suitability of the nonlinear identification techniques developed to fulfill the modeling requirements of a research program. The aircraft model and data collection are described. The identification procedures applied, the model validation tests, and the results of the parameter estimation algorithms are presented. The model is shown to be a valid representation of the real system, for both the data used in the identification and for an extended data set, by application of correlation tests and the examination of predicted behavior. ESA

**N93-18616*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

**OPERATIONAL AND RESEARCH ASPECTS OF A RADIO-CONTROLLED MODEL FLIGHT TEST PROGRAM**

Gerald D. Budd, Ronald L. Gilman (PRC Kentron, Inc., Edwards, CA.), and David Eichstedt (PRC Kentron, Inc., Edwards, CA.) Jan. 1993 18 p Presented at the 31st Aerospace Sciences Meeting, Reno, NV, 11-14 Jan. 1993

(RTOP 505-68-40)

(NASA-TM-104266; H-1881; NAS 1.15:104266; AIAA Paper 93-0625)

Avail: CASI HC A03/MF A01

The operational and research aspects of a subscale, radio-controlled model flight test program are presented. By using low-cost free-flying models, an approach was developed for obtaining research-quality vehicle performance and aerodynamic information. The advantages and limitations learned by applying this approach to a specific flight test program are described. The research quality of the data acquired shows that model flight testing is practical for obtaining consistent and repeatable flight data. Author

**N93-18783*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

**NUMERICAL INVESTIGATION OF PERFORMANCE DEGRADATION OF WINGS AND ROTORS DUE TO ICING Progress Report, 1 Jan. - 30 Jun. 1991**

Lakshmi N. Sankar and Oh J. Kwon 1991 14 p

(Grant NAG3-768)

(NASA-CR-192233; NAS 1.26:192233) Avail: CASI HC A03/MF A01

During the past five years, under the support of the NASA Lewis Research Center, a research program related to aircraft and rotorcraft icing has been underway at Georgia Institute of Technology. The objectives of this effort are: (1) develop solution techniques capable of computing 3-D unsteady viscous flow past wing-alone and rotor configurations subjected to icing; and (2) assess the performance degradation in the aerodynamic characteristics of these configurations due to icing. Work carried out during the reporting period 1 Jan. - 30 Jun. 1991 is summarized. Author

**N93-18895#** Aeronautical Systems Div., Wright-Patterson AFB, OH.

**ADVERSE WEATHER TEST SITE SELECTION STUDY Final Report, 1 Jun. 1991 - 31 May 1992**

Steven R. Christy, Ronald L. Comoglio, Robert G. Hauser, and Randy J. Lefevre Jul. 1992 94 p

(AD-A259012; ASC-TR-92-5012) Avail: CASI HC A05/MF A01

This report details the percent frequency of occurrence of the adverse weather testing criteria (as outlined in AFFTC-TIH-88-004) for five airfields: Keflavik, Iceland; Goose Bay, Canada; Bodo, Norway; Volk Field, WI; and Dover AFB, DE. The data assists selection of a single location best suited, climatologically, to perform flight testing. Criteria tested and weather conditions evaluated include artificial and natural in-flight icing and rain; wet, slushy, and icy runway/taxiway performance and handling qualities; freezing rain exposure; engine water ingestion on the ground and in-flight; evaluation of instrument flight rules (IFR) capability; evaluation of the effects of corrosive atmospheric pollutants; and turbulent flight evaluation. Numerous tables and graphs are used to demonstrate the percent frequency differences of the adverse weather conditions between the five locations. GRA

**N93-18896#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**AN EXPERIMENTAL INVESTIGATION OF A FINITE CIRCULATION CONTROL WING M.S. Thesis**

John M. Tallarovic Dec. 1992 76 p

(AD-A259044; AFIT/GAE/ENY/92D-22) Avail: CASI HC A05/MF A01

This wind tunnel investigation examined the lift, drag, and pitching moment of a 20 percent thick, 8.5 percent camber, partial elliptical cross-section,

single blowing slot, rectangular, circulation control wing. The aspect ratios tested were 3.71 and 3.99. Variables included three differently shaped trailing edge Coanda surfaces and steady blowing and pulsed blowing. The test Reynolds number, based on the chord was 500,000. The-angle of attack was varied from minus 6 degrees to the inception of stall. The maximum lift coefficient measured was 3.17 with an equivalent drag coefficient of 1.85. Results also show a limit to increasing lift by increasing the blowing. Additionally, a 90 degree Coanda surface had equal lift performance and better drag performance than a 180 degree Coanda surface. GRA

**N93-18981#** General Accounting Office, Washington, DC. National Security and International Affairs Div.

**NATIONAL AERO-SPACE PLANE: RESTRUCTURING FUTURE RESEARCH AND DEVELOPMENT EFFORTS**

Dec. 1992 57 p

(AD-A258799; GAO/NSIAD-93-71) Avail: CASI HC A04/MF A01

U.S. efforts to develop and demonstrate an aerospace plane that could achieve low earth orbit using a single stage are focused in the National Aero-Space Plane (NASP) Program. However, the program faces an uncertain future as it competes with other programs for limited federal funding at the same time its costs have escalated and its technologies remain to be developed within an ambitious schedule. Because of these and other concerns, three congressional committees asked GAO to examine various aspects of the NASP Program. This report discusses: (1) the status of the program's technology development; (2) changes in the program's projected cost and schedule; (3) the requirements for and the potential mission applications of future operational NASP-derived vehicles and efforts to spin off NASP-developed technology; and(4) issues to be decided in reassessing the direction of the program. GRA

**N93-18999#** Detroit Univ., MI. Dept. of Mechanical Engineering.

**AIRCRAFT TRAJECTORY TRACKING AND PREDICTION Final Report, Sep. 1991 - Sep. 1992**

Luis C. Cattani, Paul J. Eagle, Zhud Lin, and Xin Liu Oct. 1992 51 p

(Contract DAAA21-91-C-0085)

(AD-A259039) Avail: CASI HC A04/MF A01

Regression modeling of trajectory measurement data was examined as a means for improving the performance of aircraft trajectory tracking and prediction. Regression models were used for adaptively removing measurement noise from trajectory observations and extrapolating trajectory measurements. A comparative study was done between three models of aircraft dynamics used in an extended Kalman filter: a strictly translational model, an attitude/translation model, and an attitude/translation model that uses vehicle specific inertial characteristics. Adaptive regression models were used for measurement accuracy enhancement. Comparisons were also made between errors resulting from position and attitude predictions using Runge-Kutta integration and extrapolated regression models. GRA

**N93-19029** Missouri Univ., Rolla.

**AIRCRAFT LANDING GEAR SHIMMY Ph.D. Thesis**

Jeffrey Allen Baumann 1992 133 p

Avail: Univ. Microfilms Order No. DA9239687

In the landing gear of taxiing aircraft, shimmy is a condition of self-excited oscillation driven by the interaction between the tires and the ground. In extreme cases, shimmy can cause severe damage to landing gear hardware or even loss of the aircraft. In less extreme cases, shimmy can be little more than an annoyance. However, it does affect customer satisfaction and can cause added maintenance expense. Thus, the ability to predict and to control shimmy is important to the landing gear designer. This work discusses two analytical landing gear shimmy models. The first model, featuring an improved torsional model, is nonlinear. Its results can be integrated numerically to simulate the response of the landing gear to a specified initial disturbance. The second model is linear, combining a finite element model of the landing gear structure with a rigid or a point-contact tire model. This model can be analyzed with standard eigenvalue/eigenvector techniques to determine stability. A test case run with two models shows good correlation and illustrates the effects of changes to various parameters. Dissert. Abstr.

**N93-19034** Illinois Univ., Chicago.

**FLEXIBLE ROTORCRAFT SYSTEM DYNAMICS WITH TIME-VARIANT CONTACT CONDITIONS Ph.D. Thesis**

Mingjun Xie 1992 175 p

Avail: Univ. Microfilms Order No. DA9238366

In this thesis research an effective mathematical algorithm is developed for the dynamic analysis and simulation of flexible rotorcraft systems. A recursive matrix formulation of the equations of motion in a minimum dimension form is presented. The equations are developed for general purposes analysis and include the effects of high temperature, creep, thermal shock, elastic-plastic deformation, geometrical nonlinearities and material nonlinearities. The method used employs Kane's equations combined with the finite element method and the principle of continuum mechanics. Adjustable and time variant boundary conditions are studied for different constrained flexible systems. These include the mesh of gears, train moving on the rail and movable support. The switching of the constraints in the case of gear meshes is done by changing the nodes at contact. This is achieved by a mapping technique between the discretized finite element bodies. In addition, the rate of change of modal shapes due to the time variant boundary conditions is also considered. For validation of the results, the dynamics of a gear tooth is modeled using a modified Timoshenko beam where the acting position, direction and magnitude of the external force assumed time variant are presented. The meshing tooth is considered as a cantilever beam where the inertia forces due to the large rotation of the tooth base, as well as the external equivalent axial force and moment are included in the equations of motion. Based on the concept of time variant boundary conditions, minimization and control of vibration in elastic shafts in the dynamics of rotorcraft systems are also given. Numerical simulations supporting the broad developments of this thesis research are presented. Dissert. Abstr.

**N93-19089#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**NOZZLE/COWL OPTIMIZATION FOR A HYPERSONIC VEHICLE ON A TYPICAL TRAJECTORY M.S. Thesis**

Michael J. Bonaparte Dec. 1992 81 p

(AD-A258827; AFIT/GAE/ENY/92D-10) Avail: CASI HC A05/MF A01

An investigation of the effects of simultaneous variation of the nozzle attachment and cowl deflection angle on the performance of a two-dimensional nozzle used on a hypersonic vehicle such as the National Aero-Space Plane (NASP) was performed using a two parameter optimization procedure. Total thrust optimization was accomplished using a Flux-Difference-Split (FDS) code, a Ramjet Performance Analysis program, and an oblique shock wave solver program, at sixteen points on a 1000 psf dynamic pressure trajectory for Mach numbers from 10.0 to 25.0. A single parameter optimization of the total thrust using a variable nozzle attachment angle was accomplished first to establish a reference frame. Effects of a deflected cowl on the nozzle flow field were explored. The optimum nozzle attachment and cowl deflection angle maximized the total thrust by increasing nozzle wall pressure without an excessive increase in pressure drag. The total thrust found by the two parameter optimization was increased at every point on the trajectory over the total thrust obtained from the single parameter optimization. This study shows that the cowl deflection angle starts negative, increasing from -0.493 degrees at Mach 10 to 3.01 degrees at Mach 25. GRA

**N93-19447#** Army Lab. Command, Watertown, MA. Material Technology Lab.

**ASSESSMENT OF HELICOPTER COMPONENT STATISTICAL RELIABILITY COMPUTATIONS Final Report**

William T. Matthews and Donald M. Neal Sep. 1992 28 p

(AD-A258931; MTL-TR-92-71) Avail: CASI HC A03/MF A01

This report identifies potential errors in computing high statistical reliability for a required component fatigue life. The reliability values were determined from application of a joint probability density (JPD) analysis used in an American Helicopter Society round robin safe life problem. In the analysis normal probability density functions (PDF's) were assumed for both the material strength and the spectrum load values. The PDF model parameters were varied and the PDF's were slightly modified (contaminated) in order to examine the sensitivity in computing high statistical reliability when uncertainties exist in assuming the PDF. Lower tails of the PDF's were also modified by truncation, independent of the model contamination, in

order to determine the relative influence on reliability from tail modifications as compared with the parameter uncertainties and contamination. The stability of statistical estimates of the extreme tail quantiles and their corresponding probabilities as a function of sample size were examined for a generic distribution. Assuming a PDF to represent load or material strength is a substantially more critical issue than accurate representation of the extreme lower tail of the PDF when computing high reliability. Sampling trials for extreme tail quantiles and reliabilities indicate that unstable values can result from sample sizes of 100. The primary conclusion from these analytic results is that the computation of a high statistical reliability may have little or no association with actual engineering high reliability. GRA

**N93-19845#** General Accounting Office, Washington, DC. National Security and International Affairs Div.

**NATIONAL AERO-SPACE PLANE: RESTRUCTURING FUTURE RESEARCH AND DEVELOPMENT EFFORTS. REPORT TO CONGRESSIONAL REQUESTERS**

3 Dec. 1992 57 p

(GAO-NSIAD-93-71; B-235387) Avail: CASI HC A04/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

The Chair of the Subcommittee on Government Activities and Transportation, House Committee on Government Operations, asked us to examine the cost, feasibility, and justification for the NASP Program. In a separate request, the Chairman and Ranking Minority Member of the Subcommittee on Technology and Competitiveness, House Committee on Science, Space, and Technology, and the Chairman and Ranking Minority Member of the Subcommittee on Research and Development, House Committee on Armed Services, jointly asked us to review the NASP Program's costs, schedule, and status of the technology development plan. In this report, we discuss the status of the NASP Program's technology development; changes in the program's projected cost and schedule; the requirements for and the potential military, civil, and commercial mission applications of potential future operational vehicles and efforts to spin off NASP-developed technology; and issues to be decided in reassessing the direction of the program. Author

**N93-19849#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.

**A SIMULATION STUDY ON TAKE-OFF AND LANDING DYNAMICS OF THE AIRCRAFT OF A FLY-BY-WIRE CONTROL SYSTEM**

Yachang Feng, Gang Chen, and Peiqiong Li 7 Jan. 1993 21 p Transl. into ENGLISH from Hangkong Xuebao (China), v. 12, no. 6, Jun. 1991 p 252-258

(AD-A259286; FASTC-ID(RS)T-0313-92) Avail: CASI HC A03/MF A01

Based on the dynamic theory of rigid body systems and combined with the flying kinetic characteristics of aircraft during take-off and landing, a 6-degree of freedom aircraft equation for a rigid body system formed by the landing gear-aircraft fuselage is formulated. The pilot time-domain mathematical models for the step-target tracking was proposed, and these models will help evaluate the flying qualities of the pilot/vehicle system during take-off and landing. Then the mechanical control system and the mathematical models for the control-by-wire system are established. The total time-domain simulation procedure of the non-wire type is worked out to provide a complete quantitative analysis of the dynamic qualities in take-off and landing of aircraft, and the results agree well with the flight test data. GRA

**N93-19901#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.

**FLIGHT TESTING [LES ESSAIS EN VOL]**

Oct. 1992 405 p In ENGLISH and FRENCH Symposium held in Chania, Greece, 11-14 May 1992

(AGARD-CP-519; IBSN-92-835-0688-X) Copyright Avail: CASI HC A18/MF A04

It is considered by the Flight Mechanics Panel of AGARD as vitally important that the NATO flight test community meet regularly so that new techniques for flight test, instrumentation and data analysis and lessons learned from past and on-going programs be disseminated to ensure that safe efficient cost-effective and timely testing is accomplished. There are many new systems being tested or planned for testing in the near future. These include programmable signal processor radars, integrated flight, fire and propulsion control systems, thrust vectoring, low observable technologies, multifunction pilot displays and multisensor integration. Acquisition and processing of large quantities of avionics multiplex data are challenges that must be met. There is a need for greater use of simulators and other hardware-in-the-loop ground test facilities. For individual titles, see N93-19902 through N93-19930.

**N93-19902#** Department of Defense, Washington, DC. Testing and Evaluation Office.

**TEST AND EVALUATION CHALLENGES IN THE NINETIES**

Charles E. Adolph *In* AGARD, Flight Testing Oct. 1992 6 p (For primary document see N93-19901 06-05)

Copyright Avail: CASI HC A02/MF A04

The Flight Mechanics Panel devotes a symposium to flight testing every 3-4 years. Since the Warsaw Pact is gone, the Soviet Union no longer exists, and Germany is reunited, the United States has been involved in two limited conflicts. We are drawing down the Defense establishment in the United States to reflect the new world situation. I want to briefly discuss the Department of Defense plans for restructuring, because they have a major impact on the weapon system acquisition and test community. I.I.C.

**N93-19903#** Aerospatiale, Toulouse (France).

**FLIGHT TESTS OF THE TRANSPORT AIRCRAFT VIEWED FROM THE INDUSTRIAL STANDPOINT [LES ESSAIS EN VOL DES AVIONS DE TRANSPORT VUS SOUS LA PERSPECTIVE INDUSTRIELLE]**

G. Defer and G. Destarac *In* AGARD, Flight Testing Oct. 1992 6 p In FRENCH (For primary document see N93-19901 06-05)

Copyright Avail: CASI HC A02/MF A04

The development of new aircraft requires very heavy investments. Among these investments are the flight tests. Even if the flight tests correspond, on the average of 8 percent of the development cost, an economical approach should be taken. This is what Aerospatiale tried to do for nearly 3 decades on the main base of Toulouse Glagnac. The present development situation is described. Author

**N93-19904*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**LESSONS LEARNED FROM AN HISTORICAL LOOK AT FLIGHT TESTING**

Seth B. Anderson *In* AGARD, Flight Testing Oct. 1992 11 p (For primary document see N93-19901 06-05)

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A brief historical review of accidents was made to examine lessons learned in flight testing with major emphasis on human factors limitations. The results of this survey show undeniably that new aircraft and new pilots are not immune to old problems. Of three related human factors limitations, pilot skill frequently showed up as the primary factor responsible for accidents due to inadequate training (or proficiency) to handle an unexpected situation. A primary contributing factor was unsatisfactory aircraft handling qualities which increased pilot work load and therefore were less forgiving to 'pilot error,' particularly when flown in a stressful situation at the extremes of the flight envelope. Historically, pilot induced oscillation (PIO) has persisted as a major control problem particularly in first-flight operation. Deliberate errors involving a conscious decision to 'take a chance' by flying an aircraft with known deficiencies occurred more frequently in early times. Finally, inadvertent errors involving forgetfulness, indecision, and confusion are occurring more frequently with the current trend toward automated computerized controlled cockpits. Author

**N93-19905#** Dassault-Breguet Aviation, Saint Cloud (France).

**RAFALE: PROGRESS OF THE PROGRAM [RAFALE: AVANCEMENT DU PROGRAMME]**

Patrick Castagnos *In* AGARD, Flight Testing Oct. 1992 10 p In FRENCH (For primary document see N93-19901 06-05)

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The RAFALE C01 carried out its first flight on May 19, 1991. This event demonstrated the leading position taken on the RAFALE program, which was launched 3 years earlier by the French government and primarily designed to equip the French air forces and naval aviation as of 1997.

Author

**N93-19906#** Lockheed Advanced Development Co., Sunland, CA.
**YF-22A PROTOTYPE ADVANCED TACTICAL FIGHTER DEMONSTRATION/VALIDATION FLIGHT TEST PROGRAM OVERVIEW**
Richard Abrams *In* AGARD, Flight Testing Oct. 1992 21 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

The Lockheed Aeronautical Systems Company, teamed with the General Dynamics Fort Worth Division and Boeing Military Airplanes Company, designed, built and flight tested two YF-22A Advanced Tactical Fighter (ATF) prototypes which were powered by new prototype high thrust-to-weight ratio engines. The YF-22A design optimized the blend of low observability, maneuverability and supersonic performance. These design goals were achieved with the incorporation of many new and innovative technologies including thrust vectoring, integrated flight and propulsion control, internal weapons carriage, and composite materials. An advanced cockpit with colored liquid crystal displays, finger-on-glass controls and advanced avionics architecture was also incorporated in the prototypes. The YF-22A Demonstration/Validation (Dem/Val) flight test program was completed on the 28th of December 1990. Seventy-four flights for a total of 91.6 flight hours were accumulated on both prototypes. The first flight of YF-22A No. 1 was made on 29 September 1990, the second prototype flew on 30 October 1990. The primary objective of the Dem/Val flight test program was to demonstrate the airplane's capabilities. This approach, which prioritized the use of the aircraft as demonstrators over their use as development tools, was considered to be the most efficient method of generating the test data required for the Engineering and Manufacturing Development (EMD) proposal. The purpose of this paper is to briefly describe some of the YF-22A's unique design features and the Dem/Val flight test program. Author

**N93-19907#** Aeronautica Macchi S.p.A., Varese (Italy).
**MB-339: THE ROLE OF FLIGHT TESTING IN THE EVOLUTION PHASE OF A PROVEN AIRCRAFT**
P. Apollonio, S. Peyronel, E. Toso, and E. Trombetta *In* AGARD, Flight Testing Oct. 1992 22 p (For primary document see N93-19901 06-05)
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The MB-339 is a proven jet trainer developed by Aermacchi in the late '70s, operational within the Air Forces of 8 Countries. In order to keep pace with the increasing needs in the training syllabus mainly related to the systems management, Aermacchi launched the development of the 'C' version, equipped with an integrated, digital NAV-ATTACK system. The development program was mainly company-funded, so that a 'modular' approach to the test was adopted in order to allow the validation of the design and the achievement of operational clearance, in accordance with the needs of freezing HW/SW configuration as soon as possible on one side and to maximize the results of the agreed flight test programme on the other. A further significant activity carried out in the same time has been the ASC (Airborne Strain Counter) development, a system designed in order to satisfy the need of the Italian National Aerobatic Team for an adequate monitoring of the structural fatigue accumulated on their aircraft. Finally, Aermacchi (with Oto Melara under a contract with the Italian Ministry of Defense) is completing the program for the integration on the MB-339 of an antiship missile aimed to demonstrate the operational capability and flexibility of the aircraft. Aermacchi's particular approach to flight tests, consisting in having the flight test engineering function distributed within all technical department branches and therefore eliminating the separation between design and test engineering, provided positive results in the whole development process. Purpose of the paper is to present the characteristics of the test program carried out, to highlight the factors that allowed the full achievement of the objectives and to provide an outlook of the characteristics of the aircraft systems. Author

**N93-19908#** National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH.
**THE NATIONAL AERO-SPACE PLANE PROGRAM: A REVOLUTIONARY CONCEPT**
Robert R. Barthelemy *In* AGARD, Flight Testing Oct. 1992 9 p (For primary document see N93-19901 06-05)
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NASP - The National Aero-Space Plane - is a look into the future. It is a vision of the ultimate airplane, one capable of flying at speeds greater than 17,000 miles per hour, 25 times the speed of sound. It is the attainment of a vehicle that can routinely fly from earth to space and back, from conventional airfields, in affordable ways. It is the achievement of major technological breakthroughs that will have an enormous impact on the future growth of this nation. Most of all, it is a projection of America at its best, at its boldest, at its most creative. NASP is more than a national aircraft development program, more than the synergy of revolutionary technologies, more than a capability that may change the way we move through the world and the aerospace around it. NASP is a revolutionary technical, managerial, and programmatic concept; it is a possibility of what can be in America. The NASP program can be described in a number of ways: technological, programmatic, utilitarian, and conceptual. In each case, NASP has departed from the traditional evolutionary path. In order to achieve the vision of NASP, innovative and revolutionary approaches are required. The technical challenges require the synergism of several major technology breakthroughs. The programmatic challenges require a fundamental change in the development, management, and implementation of this strategic, high-tech program. The utility challenge requires a transformation of our thinking about aeronautical and aerospace systems. The conceptual challenge requires a paradigm shift in national planning, collaboration, and commitment. Each of these challenges, and the NASP response to them, is explored in the following pages. Author

**N93-19909#** Army Aviation Systems Command, Moffett Field, CA.
**GENERATION OF HELICOPTER ROLL AXIS BANDWIDTH DATA THROUGH GROUND-BASED AND IN-FLIGHT SIMULATION**
Heinz-Juergen Pausder (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Berlin, Germany ) and Chris L. Blanken *In* AGARD, Flight Testing Oct. 1992 15 p (For primary document see N93-19901 06-05)
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**N93-19910#** Alenia, Torino (Italy).
**AM-X HIGH ANGLE OF ATTACK FLIGHT TEST EXPERIENCE (SINGLE AND TWO SEAT VERSIONS)**
G. Menso, B. Marchetto, and E. Monforte *In* AGARD, Flight Testing Oct. 1992 13 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

This paper describes the activities carried out at the ALENIA Flight Test Center in order to investigate the high angle of attack characteristics of the AM-X. Before starting with the flight tests, vertical wind tunnel and rotary balance facilities have been used to collect all the information on aircraft behavior at stall, behind stall and in developed spin, in order to efficiently and safely approach the flight test activity. Flight tests have been tailored for the primary role of this A/C: the ground attack. Flight trails were firstly devoted to the combat configuration to assess the A/C capability to perform safe defensive maneuvers at high angle of attack. Then, a number of external stores key-configurations were tested to verify the A/C capability to safely perform vigorous maneuvers as required for such a light attack aircraft. Finally the twin seater behavior, clean and with stores, has been investigated. Analysis of the tests results provided the confidence for further investigating on developed spin characteristics and for the A/C qualification to intentional departure in a defined envelope for training purposes. Author

**N93-19911#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
**X-31A HIGH ANGLE OF ATTACK AND INITIAL POST STALL FLIGHT TESTING**
P. Huber and H. Galleithner *In* AGARD, Flight Testing Oct. 1992 11 p (For primary document see N93-19901 06-05)
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In November 1991 after about one year of successful conventional flight testing, the X-31A research aircraft no. 2 was taken to more than 30 degrees angle of attack for the first time. Since then a maximum angle of attack of about 53 degrees in 1-g flight has been achieved. This is the first time a dedicated post stall aircraft design has entered flight test beyond stall angles of attack. This paper summarizes descriptions of the control law characteristics of the X-31A and describes the flight test approach followed to safely expand and explore the high angle of attack and post stall flight regime. Furthermore, preliminary handling qualities test results obtained from the initial post stall envelope expansion are presented. Author

**N93-19912#** Dassault-Breguet Aviation, Saint Cloud (France).
**METHOD FOR DEVELOPING THE RAFALE FLIGHT CONTROL SYSTEM [METHODE DE DEVELOPPEMENT DU SYSTEME DE CONTROLE DU VOL DU RAFALE]**
P. Bourdais and R. L. Durand *In* AGARD, Flight Testing Oct. 1992 13 p In FRENCH (For primary document see N93-19901 06-05)
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The sequences are presented of the different tasks implemented for the development of the RAFALE SCV (Flight Control Program), and its design for its flight qualification, by giving details in particular of the essential points, namely the activities associated with the aerodynamic and structural modeling of the aircraft. The functional studies aim at defining the control laws, validating the SCV and its equipment in a real time flight controlled simulation environment, analyzing and processing the flight tests and incorporating these results in the adjustment phase of the SCV. Author

**N93-19913#** Instituto Superior Tecnico, Lisbon (Portugal).
**ON AUTOMATED ANALYSIS OF FLIGHT TEST DATA**
L. M. B. C. Campos (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ), A. A. Fonseca, and A. M. G. Cardoso (Portuguese Air Force Academy, Granja do Marques.) *In* AGARD, Flight Testing Oct. 1992 17 p (For primary document see N93-19901 06-05)
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The automated analysis of flight test data depends on an indicator of when an atmospheric event, or flight maneuver, starts and ends. We use as indicator the disturbance intensity, which is defined as the relative lift change, and can be related either to aerodynamic or flight dynamical parameters. A number of flight test data records, obtained using the Portuguese CASA 212 Aviocar flight test aircraft, are analyzed to show how the start and end of a maneuver are signaled by the disturbance intensity. The latter is a possible objective measure, for a proposed scale of passenger/crew comfort, somewhat analogous to the Cooper-Harper handling qualities scale. Author

**N93-19914#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Berlin (Germany).
**SYSTEM IDENTIFICATION FOR X-31A PROJECT SUPPORT: LESSONS LEARNED SO FAR**
S. Weiss, E. Plaetschke, D. Rohlf, and H. Galleithner (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany ) *In* AGARD, Flight Testing Oct. 1992 11 p (For primary document see N93-19901 06-05)
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Flight testing of the X-31A post-stall experimental aircraft started in October 1990. Within the international 'Combined X-31A Flight Test Team', DLR contributes its system identification experience and capabilities for the determination of aerodynamic parameters from flight test data. The paper presents a brief description of the hard- and software for flight test data evaluation applied by DLR to support the X-31A project on-site. It describes the different steps of the data reduction and the models used for system identification. Selected results which were achieved mainly on the basis of data from flight test conducted for handling qualities investigations are shown and compared to wind tunnel predictions. The paper discusses the aspects of on-site system identification for flight test support, including the difficulties arising from working on a low-cost program. It is based on the experience made during the initial envelope expansion of the X-31A. Author

**N93-19915#** British Aerospace Defence, Preston (England).
**IN-FLIGHT STRUCTURAL MODE EXCITATION SYSTEM FOR FLUTTER TESTING** **c08**
R. B. Ramsay *In* AGARD, Flight Testing Oct. 1992 20 p (For primary document see N93-19901 06-05)
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A system for exciting the modes of vibration of an unstable digitally controlled fly-by-wire combat aircraft via the primary control actuators in order to extract flutter data is presented. The system has been developed on the Experimental Aircraft Program (EAP) to generate, within the Flight Control computers, frequency sweep and impulse excitation signals which are injected via the primary control actuators to the foreplane and wing trailing edge flaperons. The choice of surface, actuator amplitude input and symmetric or antisymmetric excitation is pilot selectable. The system will permit predefined waveforms, referred to as test routines, to be summed into the Flight Control System (FCS) actuation loops under cockpit control. Rig and aircraft ground response performance tests were performed on the foreplane and wing outboard trailing edge flaperon actuators as part of the qualification of the system. A flight test program of 15 flights measured aircraft responses due to the injection of frequency sweeps and impulses. Results are presented for the foreplane and the wing and a comparison made with predictions and previous flight flutter tests using bonker impulsive excitation. Operation of this system demonstrated the flexibility in being able to select the excitation type and input amplitudes, optimized to the aircraft configuration and flight condition, to extract high quality data, which is the key to successful flight flutter testing. Use of this system, particularly where structural limitations restrict the use of other types of excitation, offers great potential in reducing overall testing time for aircraft with a large number of stores, provided the system is designed to have flexibility in the choice of input available to the test engineer. Author

**N93-19916*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**OVERVIEW OF THE NASA DRYDEN FLIGHT RESEARCH FACILITY AERONAUTICAL FLIGHT PROJECTS TESTING**
Robert R. Meyer, Jr. *In* AGARD, Flight Testing Oct. 1992 17 p (For primary document see N93-19901 06-05)
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Several principal aeronautics flight projects of the NASA Dryden Flight Research Facility are discussed. Key vehicle technology areas from a wide range of flight vehicles are highlighted. These areas include flight research data obtained for ground facility and computation correlation, applied research in areas not well suited to ground facilities (wind tunnels), and concept demonstration. Author

**N93-19917#** Aeroplane and Armament Experimental Establishment, Boscombe Down (England).
**HELICOPTER NIGHT VISION GOGGLE TESTING IN THE UNITED KINGDOM** **c54**
Michael R. Swales and Randall W. Cason *In* AGARD, Flight Testing Oct. 1992 12 p (For primary document see N93-19901 06-05)
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The ominous lethality of the modern battlefield necessitates the maximum exploitation of the cover afforded by darkness, making the ability to operate effectively at night a key factor in winning any major conflict. Unfortunately, the majority of the operational helicopter fleet was designed years ago with mainly daylight operations in mind. Converting these existing cockpits to an appropriate standard of night vision goggle (NVG) compatibility is no simple task. Quick fit, inexpensive fixes are rare and offer only limited value. The United Kingdom's Ministry of Defense (UK MOD) has learned this lesson well in recent years, having made large investments in both money and manpower to achieve an acceptable NVG standard of cockpit compatibility in the Sea King, Wessex, Lynx, Puma, Chinook, Gazelle, Scout and A109 helicopters. This paper will present an overview of helicopter NVG compatibility testing in the UK. A synopsis of the principles of image intensification will justify the logic behind various NVG modifications. An historic overview will then set the stage for the NVG cockpit developments, followed by a general discussion of some important compatibility issues. A review of the NVG operational assessments conducted in several different flight environments will conclude this discussion by presenting results peculiar to each environment. These wide-ranging assessments have provided the experience to develop a practical scientific approach to NVG cockpit compatibility testing which is offered in a summary of test methods.
Author

**N93-19918#** National Research Council of Canada, Ottawa (Ontario).
**FLY-BY VOICE, A TECHNOLOGY DEMONSTRATION** **c08**
J. Murray Morgan and David R. Starks (Canadian Marconi Co. Ltd., Kanata, Ontario ) *In* AGARD, Flight Testing Oct. 1992 10 p (For primary document see N93-19901 06-05)
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A connected word speech recognizer was mounted in the Flight Research Laboratory's Bell 205 Airborne Simulator (variable stability helicopter) and used to generate direct voice control over the aircraft's trajectory. The purpose of this exercise was to demonstrate the feasibility of sufficiently accurate speech recognition in the helicopter cockpit

environment to permit free use of the technology in this situation. It was not intended to postulate that primary flight control should be achieved by voice command alone. Integration of the Speech Recognizer in the cockpit proved not to be a trivial task, it was necessary to investigate and correct various technical errors in the aircraft's audio system, to modify the machine's power conversion system significantly and to deal with both inductive and audio pick-up. To enable the aircraft to be controlled adequately by the inherently low frequency voice command it was necessary to design and implement a suite of advanced control systems which could blend and switch between themselves as needed without pilot intervention and without producing aircraft behaviors which would cause the pilot concern regarding the safety of his aircraft. This paper describes the processes involved in Speech Recognizer integration and control word system development and concludes that connected speech recognition is viable as a useful and realizable adjunct to the advanced helicopter cockpit. Author

**N93-19919#** National Aerospace Lab., Amsterdam (Netherlands).
**FLIGHT TESTING OF GPS AND GPS-AIDED SYSTEMS**
O. B. M. Pietersen, M. A. G. Peters, and N. vanDriel *In* AGARD, Flight Testing Oct. 1992 11 p (For primary document see N93-19901 06-05)
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In three years of GPS (Global Positioning System) testing by the National Aerospace Laboratory NLR in the Netherlands, the complexity of the systems evaluated has increased considerably, from a stand-alone GPS receiver to an integrated navigation system in which GPS is one of the sensors. This paper describes in short a number of flight test programs carried out by NLR, namely (1) trials to investigate the suitability of differential GPS for precision approaches; (2) trials to determine the advantages of aiding a GPS receiver by INS (Inertial Navigation System) and of the use of null-steering antennas; and (3) trials to evaluate an in-house developed navigation filter in which three navigation sensors, GPS, INS and TRN (Terrain Referenced Navigation) were integrated. It is concluded that an integrated navigation system can offer a greater robustness and a higher accuracy of the navigation solution, taking into account the weaknesses the individual sensors have. Differential GPS can eliminate a number of systematic errors, improving the attainable accuracy. Author

**N93-19920#** Aerodata Flugmesstechnik G.m.b.H., Brunswick (Germany).
**HIGH PRECISION NAVIGATION FOR FLIGHT TESTING (AERONAV)** **c04**
P. Voersmann, M. Haverland, and G. Schaenzer (Technische Univ., Brunswick, Germany ) *In* AGARD, FLight Testing Oct. 1992 11 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

The combination of Global Navigation Satellite Systems and inertial sensors can achieve extremely high accuracies in position, speed, turn rate, attitude, and acceleration of a flight vehicle. This paper presents the application of AeroNav to flight testing. AeroNav is an Integrated Navigation system, which has been co-developed between Aerodata and the Institute of Flight Guidance of the Technische Universitat Braunschweig. Due to its tight coupling between satellite and inertial sensors it can be used as the basic system for flight performance measurements and handling quality testing. Furthermore it has the potential to meet the accuracy requirements as position reference for autoland certification and ILS/MLS flight calibration. Flight and ground test results are shown, which use an independent position reference for accuracy validation. Author

**N93-19921#** Industrie Aeronautiche e Meccaniche Rinaldo Piaggio S.p.A., Genoa (Italy).
**NATURAL LAMINAR FLOW TEST IN-FLIGHT VISUALIZATION** **c02**
G. Sacco, P. Cinquetti, and S. Martini *In* AGARD, Flight Testing Oct. 1992 8 p (For primary document see N93-19901 06-05)
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This paper presents an overview of the test campaign performed on the Piaggio P.180 'Avanti' aircraft in order to develop and obtain the maximum natural laminar flow on the lifting surfaces. The paper reports the development of new profile family that could allow not only good laminarity flow characteristics in the aircraft flight envelope but also favorable pressure distribution and performance results. The wind tunnel and in-flight visualization as well as the effects of natural laminar flow airfoil contamination are herein described. Sublimating chemicals techniques have been employed to test the design airfoils even if this approach allowed only one test point per flight. Positive results were however achieved and demonstrated the positive effects of such a design philosophy. Author

**N93-19922#** Calspan Corp., Arnold AFS, TN. Arnold Engineering Devlopment Center.
**A TECHNIQUE FOR PREDICTING AIRCRAFT FLOW-FIELD EFFECTS UPON AN UNGUIDED BOMB BALLISTIC TRAJECTORY AND COMPARISON WITH FLIGHT TEST RESULTS** **c02**
H. Paschall Massengill, Jr. *In* AGARD, Flight Testing Oct. 1992 12 p (For primary document see N93-19901 06-05)
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Accurate aircraft delivery of unguided munitions requires that an aircraft onboard targeting algorithm account for the free-stream drag characteristics of a released store as well as the effects of ejection forces and aircraft-induced aerodynamic flow-field transients. Of the three, aerodynamic flow-field effects are the most difficult to predict. The current state of weapon delivery technology requires that many hours of flight testing be conducted and the test data analyzed to form a significant foundation upon which to build an accurate flow-field compensation algorithm. The proposed use of ground simulation techniques in lieu of flight test techniques to achieve accurate aircraft delivery of unguided weapons is the thesis of this paper. A method was developed to permit application of ground simulation techniques to the challenging arena of aircraft weapon delivery accuracy. The method was tested by correcting a flow-field compensation algorithm for a typical supersonic tactical aircraft and comparing the resultant aircraft bombing accuracy with that attained using traditional state-of-the-art flight testing techniques. Preliminary results indicate that good aircraft bombing accuracy can be achieved using only ground simulation techniques. Success of the method offers the potential to reduce the cost of producing an accurate aircraft weapon delivery algorithm by an order of magnitude and the time required by three-fourths. Planned future efforts will attempt to expand method validity into increasingly demanding regions of the flight envelope. Author

**N93-19923#** Naval Air Warfare Center, China Lake, CA.
**DEVELOPMENT AND FLIGHT TESTING OF THE MULTI-SOURCE INTEGRATION ALGORITHMS IN THE F/A-18 MISSION COMPUTER SOFTWARE** **c61**
J. J. Crutchfield *In* AGARD, Flight Testing Oct. 1992 5 p (For primary document see N93-19901 06-05)
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This paper presents the newest innovation in air-to-air weapons employment capabilities, Multi-Source Integration (MSI). The integrating of a diverse suite of sensors on the F/A-18 Hornet has been the most significant avionics development effort attempted on a modern operational tactical aircraft. MSI is incorporated as statistical algorithms which merge spatial kinematic and identification data from the suite of sensors on board the aircraft. This merged data becomes trackfiles which are displayed to the pilot for the prosecution of an attack. Author

**N93-19924#** Test Wing (6510th), Edwards AFB, CA.
**TESTING OF AN AUTOMATIC, LOW ALTITUDE, ALL TERRAIN GROUND COLLISION AVOIDANCE SYSTEM** **c04**
M. A. Skoog and T. H. Ascough *In* AGARD, Flight Testing Oct. 1992 20 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

Flight test results and analysis techniques are presented for an automatic All Terrain Ground Collision Avoidance System (AT GCAS). The AT GCAS was flight demonstrated on the Advanced Fighter Technology Integration (AFTI)/F-16 and hosted on a production digital F-16 flight control system. Over 200 automatic recoveries were initiated at dive angles up to 50 degrees, all bank angles, and airspeeds ranging from 270 to 570 knots. New methods were developed to analyze data, allowing identification of subsystem error contributions. The resulting system performance is presented with conclusions. Author

**N93-19925#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction des Etudes de Synthese.
**RAMSES: MULTI-SPECTRAL EXPERIMENTAL RADAR STATION INSTALLED ON BOARD THE TRANSALL [RAMSES: STATION RADAR EXPERIMENTALE MULTI-SPECTRALE EMBARQUEE SUR TRANSALL]** **c32**
J. M. Boutry and D. LeCoz *In* AGARD, Flight Testing Oct. 1992 8 p In FRENCH (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A02/MF A04

Within the context of studies devoted to onboard radar applications (missiles, aircraft, satellites, etc.), ONERA is developing and implementing, with the support of the General Delegation for Armament and in collaboration with the Flight Testing Center of Bretigny, a radar experimental station installed onboard a Transall. This permits a parametric study of the radar operating modes and the associated methods of signal processing. The areas in which the station is used are introduced, while examining in particular the problem of the transposition of the radar and geometric parameters. Then, the main technical features of the station are reviewed. Finally, a few examples of the preliminary results are described. Author

**N93-19926#** Aerospatiale, Toulouse (France).
**USE OF A TRIAXIAL LASER VELOCIMETER FOR ANEMOMETRIC CALIBRATION ON AN A340 AIRBUS [UTILISATION D'UN VELOCIMETRE LASER TRIAXE POUR CALIBRATION ANEMOMETRIQUE SUR AIRBUS A340]** **c36**
F. Cattin-Valsecchi and C. Lopez *In* AGARD, Flight Testing Oct. 1992 10 p In FRENCH (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A02/MF A04

Calibration of the anemometric and clinometric system is an essential phase of the test campaign in the development of an aircraft. The general operating principle of a laser velocimeter is explained along with the technical specifications and installation of the apparatus, developed by the 'Sextant Avionique' company for Aerospatiale. The advantages offered by the new analysis methods using the laser velocimeter are reviewed. Author

**N93-19927#** British Aerospace Defence, Preston (England).
**DEVELOPMENT AND FLIGHT TESTING OF A SURFACE PRESSURE MEASUREMENT INSTALLATION ON THE EAP DEMONSTRATOR AIRCRAFT** **c35**
G. J. Watson *In* AGARD, Flight Testing Oct. 1992 13 p (For primary document see N93-19901 06-05)
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This paper describes a project to develop and flight test a surface pressure measurement system on the UK Experimental Aircraft Program demonstrator aircraft. The paper begins with a brief description of the potential benefits of developing such a system. This is followed by the results and conclusions of development tests involving Wind Tunnel measurements and some preliminary Flight Trials. The installation details for the main Flight Test Trials are then described and the final results from the system are presented, compared with predictions based on previous Wind Tunnel measurements. The capability of the system to provide pressure distribution data of interest to the Aerodynamicist and integrated component loads for Flight Clearance purposes is demonstrated, and its usefulness as a Flight Testing technique is discussed. Author

**N93-19928#** Kaman Aerospace Corp., Bloomfield, CT.
**AN IMPROVED METHOD OF STRUCTURAL DYNAMIC TEST DESIGN FOR GROUND FLYING AND ITS APPLICATION TO THE SH-2F AND SH-2G HELICOPTERS**
C. A. Tomashofski, E. J. Nagy, and P. E. Keary *In* AGARD, Flight Testing Oct. 1992 23 p (For primary document see N93-19901 06-05)
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An improved method of structural dynamic test design was developed at Kaman Aerospace Corporation over the past several years. The method, Generalized Force Determination or GFD, grew from experience using basic force determination during the early 1980's. Basic force determination was found to work extremely well for many types of fatigue test setups with limited matching criteria. In other tests, it was found that certain combinations of actuators and matching criteria would render the test rig impossible to calibrate. Basic force determination could not be used for those cases. Since then, the source of the difficulty has been identified, and fundamental theoretic foundations have been built by William G. Flannelly (of Kaman Aerospace Corp.) to generalize the process of force determination for essentially any type of fatigue test arrangement. In addition, GFD has grown into a complete, automated, turn-key software package which guides the test engineer to the best possible solution within the constraints of the available test hardware and provides concrete insight into ways of adapting the hardware arrangement to improve the solution even further. The theoretical foundations are presented in broad outline in this paper. The fatigue tests done on full scale SH-2 helicopters which verified the practical applicability of GFD are described also. The steps in the complete GFD system were honed by the practical knowledge gained during the conduct of these tests. Author

**N93-19929#** Technische Hogeschool, Delft (Netherlands).
**ON-LINE AIRCRAFT STATE AND PARAMETER ESTIMATION**
M. Laban *In* AGARD, Flight Testing Oct. 1992 23 p (For primary document see N93-19901 06-05)
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Detailed mathematical models of aircraft aerodynamics find their use in aircraft design evaluation, flight simulation, control system tuning, and aircraft certification. Unknown parameters in these models can be extracted from flight test data by means of a variety of system identification techniques. This paper shows how on-line aerodynamic model identification has become feasible by applying algorithms based on a decomposition of the state and parameter estimation problem and the application of a high speed multi-processor computer system. Results from a recent flight test program are presented. Author

**N93-19930#** National Research Council of Canada, Ottawa (Ontario).
**THE FLIGHT TEST AND DATA ANALYSIS PROGRAM FOR THE DEVELOPMENT OF A BOEING/DE HAVILLAND DASH 8 SIMULATOR MODEL**
Stewart W. Baillie, Ken Hui, and Jaap DeLeeuw (AERCOL, Downsview, Ontario ) *In* AGARD, Flight Testing Oct. 1992 19 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

A joint program between CAE Electronics Ltd., Montreal, and the Flight Research Laboratory, NRC, was conducted to develop high fidelity simulator models of the Dash 8 Series 100 and 300 aircraft. This paper focuses primarily on the Series 100 program. The flight test portion of the program entailed a relatively limited set of instrumentation due to aircraft ownership and regulatory constraints. The primary measurements were the basic inertial quantities and flight path reconstruction techniques were used to generate the time histories of other required flight path parameters (such as angle of attack and sideslip). The major portion of flight test data was analyzed using Maximum Likelihood Estimation with reliance on trim condition data for initial model estimates. The final simulator model was validated using specifically designated maneuvers conducted solely for validation purposes. Author

**N93-19004#** Technische Univ., Delft (Netherlands).
**AIRCRAFT PERFORMANCE IN PRACTICE [VLIEGTUIGPRESTATIES IN DE PRAKTIJK]**
H. Wickardt *In its* Professor Wittenberg: His Speciality and Versatility 1991 p 29-41 In DUTCH (For primary document see N93-19002 06-01)
Copyright Avail: CASI HC A03/MF A01

**N93-19005#** KLM Helikopters B.V., Amsterdam (Netherlands).
**HELICOPTERS IN ACTION [HELIKOPTERS IN AKTIE]**
H. W. C. L. Schoevers *In* Technische Univ., Professor Wittenberg: His Specialty and Versatility 1991 p 43-57 In DUTCH (For primary document see N93-19002 06-01)
Copyright Avail: CASI HC A03/MF A01

**N93-19322#** National Aerospace Lab., Tokyo (Japan).
**ON THE ROLES OF WIND TUNNEL TESTING AND COMPUTATIONAL FLUID DYNAMICS IN THE AIRCRAFT DEVELOPMENT [KOUKUUKI KAIHATSU NI OKERU FUUDOU SHIKEN TO CFD]**
Susumu Takanashi *In its* Proceedings of the Ninth NAL Symposium on

Aircraft Computational Aerodynamics Dec. 1991 p 313-318 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

**N93-19453*#** North Carolina Agricultural and Technical State Univ., Greensboro. Structures Group.
**STRUCTURES RESEARCH**
Elias Abu-Saba, Williams McGinley, and Ji-Yao Shen *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 10 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

**N93-19460*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. Center for Aerospace Research.
**LUMPED MASS MODELLING FOR THE DYNAMIC ANALYSIS OF AIRCRAFT STRUCTURES**
Elias G. Abu-Saba (North Carolina Agricultural and Technical State Univ., Greensboro.), Ji Yao Shen (North Carolina Agricultural and Technical State Univ., Greensboro.), William M. McGinley (North Carolina Agricultural and Technical State Univ., Greensboro.), and Raymond C. Montgomery *In* North Carolina Agricultural and Technical State Univ., The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 10 p Submitted for publication (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

## 06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

**N93-18270#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
**JOINT INTEGRATED AVIONICS WORKING GROUP (JIAWG) OBJECT-ORIENTED DOMAIN ANALYSIS METHOD (JODA), VERSION 3.1 Final Report**
Robert Holibaugh Nov. 1992 100 p
(Contract F19628-90-C-0003)
(AD-A258468; CMU/SEI-92-SR-3) Avail: CASI HC A05/MF A02

The Joint Integrated Avionics Working Group (JIAWG) Reuse Subcommittee has initiatives in several areas to demonstrate that reuse can effectively support the JIAWG programs, and the creation of reusable assets is an essential element of reuse. Domain analysis is the process that identifies what is reusable, how it can be structured, and how it can be used. A method for domain analysis that is based on Coad and Yourdon's Object Oriented Analysis is desribed. This method, the JIAWG Object-Oriented Domain Analysis (JODA), includes several enhancements to the method of Coad and Yourdon and produces a domain model to support asset creation and reuse. GRA

**N93-18408*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**MANUAL FLYING OF CURVED PRECISION APPROACHES TO LANDING WITH ELECTROMECHANICAL INSTRUMENTATION. A PILOTED SIMULATION STUDY**
Charles E. Knox Washington Feb. 1993 41 p
(RTOP 505-64-13-01)
(NASA-TP-3255; L-16964; NAS 1.60:3255) Avail: CASI HC A03/MF A01

A piloted simulation study was conducted to examine the requirements for using electromechanical flight instrumentation to provide situation information and flight guidance for manually controlled flight along curved precision approach paths to a landing. Six pilots were used as test subjects. The data from these tests indicated that flight director guidance is required for the manually controlled flight of a jet transport airplane on curved approach paths. Acceptable path tracking performance was attained with each of the three situation information algorithms tested. Approach paths with both multiple sequential turns and short final path segments were evaluated. Pilot comments indicated that all the approach paths tested could be used in normal airline operations. Author

**N93-19023*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**STALL DEPARTURE RESISTANCE ENHANCER Patent Application**
Holly M. Ross, inventor (to NASA), Joseph L. Johnson, Jr., inventor (to NASA), Long P. Yip, inventor (to NASA), and H. Paul Stough, III, inventor (to NASA) 4 Jan. 1993 10 p
(NASA-Case-LAR-14221-1; NAS 1.71:LAR-14221-1; US-Patent-Appl-SN-000064) Avail: CASI HC A02/MF A01

A stall departure resistance enhancer for an aircraft for controlling flow separation by inducing vortical flow over the upper surface of the wing is described. A flat triangular plate is secured to a leading edge of the wing to reduce drag, and the tip of the triangular plate is sharp and the edges are thin and sharp to induce good vortical flow. The thickness of the plate is minimal, but it is sufficient so that the plate remains rigid for all angles of attack. A tip of the triangular plate protrudes forward from the leading edge of the wing, and the centerline of the triangular plate extending through the tip is aligned in the freestream direction. In a second embodiment, the triangular plate is hingedly secured to the leading edge of the wing, and a stop is provided to limit the hinged movement of the plate at or near the stall angle of attack. NASA

**N93-19110*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**FLIGHT AND WIND-TUNNEL CALIBRATIONS OF A FLUSH AIRDATA SENSOR AT HIGH ANGLES OF ATTACK AND SIDESLIP AND AT SUPERSONIC MACH NUMBERS**
Timothy R. Moes, Stephen A. Whitmore, and Frank L. Jordan, Jr. (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) Feb. 1993 33 p Presented at the AIAA/AHS/ASEE Aerospace Design Conference, Irvine, CA, 16-19 Feb. 1993
(RTOP 505-68-30)
(NASA-TM-104265; H-1875; NAS 1.15:104265; AIAA Paper 93-1017)
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A nonintrusive airdata-sensing system was calibrated in flight and wind-tunnel experiments to an angle of attack of 70 deg and to angles of sideslip of +/- 15 deg. Flight-calibration data have also been obtained to Mach 1.2. The sensor, known as the flush airdata sensor, was installed on the nosecap of an F-18 aircraft for flight tests and on a full-scale F-18 forebody for wind-tunnel tests. Flight tests occurred at the NASA Dryden Flight Research Facility, Edwards, California, using the F-18 High Alpha Research Vehicle. Wind-tunnel tests were conducted in the 30- by 60-ft wind tunnel at the NASA LaRC, Hampton, Virginia. The sensor consisted of 23 flush-mounted pressure ports arranged in concentric circles and located within 1.75 in. of the tip of the nosecap. An overdetermined mathematical model was used to relate the pressure measurements to the local airdata quantities. The mathematical model was based on potential flow over a sphere and was empirically adjusted based on flight and wind-tunnel data. For quasi-steady maneuvering, the mathematical model worked well throughout the subsonic, transonic, and low supersonic flight regimes. The model also worked well throughout the angles-of-attack and -sideslip regions studied. Author

**N93-19783#** Sextant Avionique, Saint Medard en Jalles (France).
**LIQUID CRYSTAL DISPLAYS REPLACING THE CRT AND CLE OF FUTURE COCKPITS [LES ECRANS A CRISTAUX LIQUIDES REMPLACANT DU CRT ET CLE DES FUTURS COCKPITS]**
Frederic deLauzun *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 9 p In FRENCH (For primary document see N93-19757 06-54)
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# 07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

**N93-17849#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Paris (France).

**SNECMA M88 ENGINE DEVELOPMENT STATUS**

J. C. Corde 1991 5 p Repr. from Transactions of the ASME, v. 113, Jan. 1991 p 20-24 Presented at 35th International Gas Turbine and Aeroengine Congress and Exposition, Brussels, Belgium, 11-14 Jun. 1990 Previously announced in IAA as A91-23636

(ASME-90-GT-118; ETN-93-93377) Avail: CASI HC A01/MF A01

The historical origins of the SNECMA M88 engine development program are described and the general development planning until the production engine flight qualification at the end of 1995 is presented. The technical aspects of the program are emphasized. The main new technologies involved in the engine, the general arrangement, and the performance are described and the engine development status is fully presented (development philosophy, main component tests, and complete engine tests). ESA

**N93-17851#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France). Combustion Dept.

**TURBINE ENGINE COMBUSTOR DESIGN AT SNECMA**

M. Desaulty 1991 8 p Presented at 10th ISABE International Symposium on Air Breathing Engines, Nottingham, England, 1-6 Sep. 1991 Previously announced in IAA as A91-56108

(DS-2129; ETN-93-93389) Avail: CASI HC A02/MF A01

Research on the technologies and calculation methods needed to meet the performance, cost, and deadline requirements for future engines is described. It is suggested that attention should focus on structure and coding and injection techniques when designing combustors. The required performance is outlined, the combustor operation is explained, and technological research challenges to military and civil aircraft are addressed. Technological research addresses injection systems and new combustor structures (double annular combustor and variable geometry combustors). Calculation methods, particularly the two and three dimensional Navier-Stokes codes, which have improved flow understanding and thus enabled costs to be reduced and deadlines shortened for the development of new concepts, are discussed. ESA

**N93-17882#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).

**THE TECHNOLOGICAL EVOLUTION OF HIGH THRUST TURBINE ENGINES**

Roger Bouillet (Ecole Nationale Superieure d'Arts et Metiers, Paris, France) 1984 18 p Repr. from L'Aeronautique et L'Astronomique, v. 4, no. 107, 1984 p 29-46 In FRENCH Previously announced in IAA as A85-26017

(DS-1881; ETN-93-93383) Avail: CASI HC A03/MF A01

Because of design compromises, operational qualities expected from advanced turbine engines have lead to the introduction of typical formulae of engines. These formulae are discussed in the context of the complete engine and its major components (fans, compressor, combustors, turbines). The evolutions of the current technologies most likely to occur during the new decade are evaluated. The principle factors affecting the operational qualities of civil and military engines are reviewed: pollution, reliability/security, life duration/maintenance, type of engine. The integration of the different parts and the materials used are addressed. ESA

**N93-18127#** Cranfield Inst. of Tech., Bedford (England). School of Mechanical Engineering.

**ADVANCED TACTICAL FIGHTER ENGINE DESIGN: FRONT FAN M.S. Thesis**

P. W. Mountain Aug. 1990 236 p

(ETN-93-92998) Avail: CASI HC A11/MF A03

One of two theses in a joint project to design a propulsion system for an advanced supersonic cruise fighter/interceptor for the late 1990s and on into the 21st century is presented. The specifications for the aircraft, its characteristics, and propulsion requirements are covered. Various engine options available are outlined and the optimization of two cycles (turbojet and turbofan) are detailed. The final choice of a turbofan engine is justified and further optimization carried out is described. The aerothermodynamic design of a front fan turbofan engine is detailed. Emphasis is on the design of the low pressure compressor and turbine but the design of the high pressure compressor and combustion chamber is also considered. ESA

**N93-18149#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry (France). Dept. Materiaux et Procedes.

**FATIGUE OF TURBOENGINE DISCS**

E. Bachelet and J.-Y. Guedou 5 May 1991 11 p Repr. from Memoires et Etudes Scientifiques Revue de Metallurgie, Jun. 1991 p 369-379 In FRENCH Presented at INSTN Journees de Metallurgie, Jun. 1989

(DS-2136; ETN-93-93387) Avail: CASI HC A03/MF A01

Mechanical fatigue in turboengines is addressed. This takes account of the fatigue in the case of compressors or turbine disks in their technical or even economical context. Methods performed to deal with them are reviewed. The main problems practitioners working in this field have to solve are presented. The expectations of clients in terms of performance, reliability and costs are addressed. The thermal and mechanical applications of the materials are discussed. Methods of determining the life duration of the parts are addressed. Developments in the metallurgical field are considered with particular attention given to short crack propagation. ESA

**N93-18151#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry (France). Direction de la Qualite.

**CONTROL OF IN-SERVICE DAMAGE: APPLICATION TO AIRCRAFT ENGINES [CONTROLE DE L'ENDOMMAGEMENT EN SERVICE: APPLICATION AUX MOTEURS D'AVION]**

J. M. Theret 1991 20 p In FRENCH Presented at Journees de Printemps de la Societe Francaise de Metallurgie et de Materiaux Commission de Fatigue des Materiaux on Amorcage en Fatigue en Compteurs de Dommages, Paris, France, 28-29 May 1991

(DS-2027; ETN-93-93391) Avail: CASI HC A03/MF A01

Precautions taken in order to control engine damage, which are necessary if good safe engine performance is to be guaranteed, are addressed. The critical engine parts are those whose rupture could cause major damage to the aircraft. The control of damage takes several forms and each of these are discussed: design validation through studies of engine aging and life duration of the individual parts; the surveillance of engines through constant verification of selected parameters and through periodic controls in order to find sites of possible damage before real harm is caused; and the control of damage to decide whether the part is withdrawn or whether it undergoes further tests. Examples of nondestructive tests performed are given. ESA

**N93-18578*#** Pratt and Whitney Aircraft, East Hartford, CT. Commercial Engineering.

**CREEP FATIGUE LIFE PREDICTION FOR ENGINE HOT SECTION MATERIALS (ISOTROPIC) Final Report, May 1987 - Feb. 1989**

R. S. Nelson, G. W. Levan, and P. R. Harvey Aug. 1992 109 p (Contract NAS3-23288; RTOP 590-21-11)

(NASA-CR-189221; NAS 1.26:189221; PWA-5894) Avail: CASI HC A06/MF A02

This Final Report covers the activities completed under the optional program of the NASA HOST Contract, NAS3-23288. The initial effort of the optional program was report-in NASA CR189221, which consisted of high temperature strain controlled fatigue tests to study the effects of thermomechanical fatigue, multiaxial loading, reactive environments, and imposed stresses. The baseline alloy used in the tests included B1900+Hf (with or without coating) and wrought INCO 718. Tests conducted on B1900+Hf included environmental tests using various atmospheres (75 psig oxygen, purified argon, or block exposures) and specimen tests of wrought INCO 718 included tensile, creep, stress rupture, TMF, multiaxial, and mean stress tests. Results of these testings were used to calibrate a CDA model for INCO 718 alloy and to develop modifications or corrections to the CDA model to handle additional failure mechanisms. The Socie parameter was found to provide the best correlation for INCO multiaxial

loading. Microstructural evaluations consisting of optical, Scanning Electron Microscopy (SEM), and Transmission Electron Microscopy (TEM) techniques, and surface replication techniques to determine crack initiation lives provided data which were used to develop life prediction models. Author

**N93-18628#** Universitaet der Bundeswehr Muenchen, Neubiberg (Germany). Fakultaet fuer Luft- und Raumfahrttechnik.
**EXPERIMENTAL AND NUMERICAL EXAMINATIONS OF THE INFLUENCE OF INLET DISTORTION PERTURBATIONS ON THE WORKING BEHAVIOR OF TURBOFAN COMPRESSORS Ph.D. Thesis [EXPERIMENTELLE UND NUMERISCHE UNTERSUCHUNGEN ZUM EINFLUSS VON EINTRITTSDRALLSTOERUNGEN AUF DAS BETRIEBSVERHALTEN VON FLUGTRIEBWERKSVERDICHTERN]**
Wolfram Pazur 1991 180 p In GERMAN
(ETN-93-92733) Avail: CASI HC A09/MF A02

Examinations of a compressor integrated in a turbofan were carried out to consider the interaction effects between independent components. A test facility was built to study the behavior of the low pressure compressor of Larzac O4: a distortion generator that was designed with a delta wing to create simulated turbofan instabilities. The compressor inlet and exhaust temperatures were measured by means of thermocouples (Fe-Co, Ni-Cr-Ni). Two pressure probes were introduced through existing openings in the air intake to measure the total pressure. A numerical model was developed to describe stationary distortion perturbations through an axial compressor and the pressure losses and was extended to the nonstationary case. The results were compared with experimental data and a good estimation was found for isentropic efficiency and compression ratio. It is shown that a distortion perturbation induces changes in the characteristic line of the compressor but does not influence its dynamic characteristics. This phenomenon is experimentally proved and established by a power synthesis calculation. ESA

**N93-18702*#** General Motors Corp., Indianapolis, IN.
**INVESTIGATION OF ADVANCED COUNTERROTATION BLADE CONFIGURATION CONCEPTS FOR HIGH SPEED TURBOPROP SYSTEMS. TASK 4: ADVANCED FAN SECTION AERODYNAMIC ANALYSIS COMPUTER PROGRAM USER'S MANUAL Report, Jul. 1991 - Jul. 1992**
Andrew J. Crook and Robert A. Delaney Nov. 1992 70 p
(Contract NAS3-25270)
(NASA-CR-187127; NAS 1.26:187127) Avail: CASI HC A04/MF A01

The computer program user's manual for the ADPACAPES (Advanced Ducted Propfan Analysis Code-Average Passage Engine Simulation) program is included. The objective of the computer program is development of a three-dimensional Euler/Navier-Stokes flow analysis for fan section/engine geometries containing multiple blade rows and multiple spanwise flow splitters. An existing procedure developed by Dr. J. J. Adamczyk and associates at the NASA Lewis Research Center was modified to accept multiple spanwise splitter geometries and simulate engine core conditions. The numerical solution is based upon a finite volume technique with a four stage Runge-Kutta time marching procedure. Multiple blade row solutions are based upon the average-passage system of equations. The numerical solutions are performed on an H-type grid system, with meshes meeting the requirement of maintaining a common axisymmetric mesh for each blade row grid. The analysis was run on several geometry configurations ranging from one to five blade rows and from one to four radial flow splitters. The efficiency of the solution procedure was shown to be the same as the original analysis. Author

**N93-18997#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DEVELOPMENT OF AN ENGINE/AIRFRAME PERFORMANCE MATCHING SCHEME FOR JET ENGINE RETROFIT M.S. Thesis**
Alan Lach Dec. 1992 156 p
(AD-A258822; AFIT/GAE/ENY/92D-19) Avail: CASI HC A08/MF A02

This investigation developed a procedure and new analysis tools for identifying retrofit engine designs for use in existing airframes. The goal was to find a replacement engine for the air-to-air fighter, AAF, developed in the textbook Aircraft Engine Design. This paper introduced the ideas of solution surfaces, constraint/thrust diagrams, quality measures and linear regression analysis for the engine design problem. It considered the application of the jet engine design software ACSYS, MISS, and ONX along with statistical analysis software, SAS. Modeling techniques and linear regression analysis were used to minimize iteration while searching a wide range of design variables. Improvements to the design point engine selection process were made through the development of quality measures for choosing appropriate values for bypass ratio and compressor pressure ratio. The analysis tools were assembled into a design scheme for engine retrofit which was then demonstrated with a two-variable and a six-variable design example. The result of the study determined a new baseline engine design for the AAF with increased thrust and decreased fuel consumption. This design process was developed for use by design students in the academic environment. GRA

**N93-19093#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CHARACTERIZATION OF STALL INCEPTION IN HIGH-SPEED SINGLE-STAGE COMPRESSORS M.S. Thesis**
Keith M. Boyer Dec. 1992 157 p
(AD-A258973; AFIT/GAE/ENY/92D-21) Avail: CASI HC A08/MF A02

Two single-stage, transonic compressor designs were tested under various undistorted operating conditions to characterize the process leading up to aerodynamic stall. The rig case was instrumented with eight high-response static pressure transducers equally spaced around the annulus for stall development detection. High-response measurements were low-pass filtered and both spatially and temporally analyzed using discrete Fourier techniques. At all speeds tested for both designs, stall inception was characterized by growth of a small amplitude rotating wave. The waves did not grow significantly until just prior to the instability, when exponential growth into fully-developed rotating stall occurred very rapidly, within 6-10 rotor revolutions. The amount of time the rotating waves could be detected prior to stall varied considerably with compressor operating condition and was largely dependent on the local slope of the compressor speedline characteristics. Stall warning times ranged from less than one-tenth of a second to more than two seconds for the same machine operated at different high speeds (above 60 percent design speed). The influence of compressibility effects are also discussed. GRA

**N93-19356#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**INTEGRATED BLADE INSPECTION SYSTEM (IBIS) UPGRADE STUDY M.S. Thesis**
Tony J. DeLiberato, Steven W. Perkins, Steven K. Saplin, John G. Snyder, and Gregory J. Toussaint Dec. 1992 294 p
(AD-A258912; AFIT/GSE/ENY/92D-03) Avail: CASI HC A13/MF A03

The purpose of this design study was to identify ways to improve the Integrated Blade Inspection System. The Air Force requires inspection of jet engine compressor and turbine blades to locate defects and prevent engine failure. The current inspection process uses fluorescent penetrant as an aid to identify cracked blades. A systems engineering design process was applied to evaluate the current inspection techniques and to develop alternative methods to satisfy the Air Force requirements. Three different inspection systems were developed and compared to the current process: manual, semi-automated, and fully automated inspection. This study made several noteworthy contributions: development of classification software to validate the neural network approach for accurate blade classification, demonstration of potential advantages of charge-coupled device cameras for data gathering, quantification of the cost of incorrectly classifying jet engine blades, examination of the value of a statistical quality control plan for the inspection process, and identification of a method using multiple images to extract additional features from cracks. The study demonstrates that the fully automated system could dramatically outperform the manual inspection process by improving the consistency of the inspection process and raising the quality of the blades returned to service. GRA

**N93-19326#** Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
**ROLE OF WIND TUNNEL TESTS AND CFD ANALYSIS FOR THE DEVELOPMENT OF AERO-ENGINES IN IHI [IHI KOUKUU ENJIN NI OKERU FUUDOU JIKKEN TO CFD]**
Atsushige Tanaka *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 337-344 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

# 08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

**N93-18142#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**INTRODUCTION TO FLUTTER OF WINGED AIRCRAFT, VOLUME 1**
1992 356 p Lecture series held in Rhode-Saint-Genese, Belgium, 9-13 Dec. 1991
(VKI-LS-1992-01; ETN-93-92618) Avail: CASI HC A16/MF A03

This volume is part of a lecture series in which a number of basic and new ideas on wing flutter are presented to both the uninitiated and experienced engineer. The lectures were designed to present the physical phenomenon, the mathematical modeling of the physics (covering the interaction among the inertial and elastic energies of the wing with the energies associated with the airstream), and the instability of the wing that might arise. In this volume a single paper concerning the unified method of elasticity is presented. The basic concepts of the unified method needed by engineers in understanding the techniques for incorporating aeroelastic effects in stability analyses of winged aircraft are presented, and practical procedures for performing such analyses are given. For individual titles, see N93-18143 through N93-18143.

**N93-18143#** Naval Academy, Annapolis, MD. Dept. of Mechanical Engineering.
**THE UNIFIED METHOD OF AEROELASTICITY**
Robert A. Granger *In* VKI, Introduction to Flutter of Winged Aircraft, Volume 1 1992 347 p (For primary document see N93-18142 06-08)
Avail: CASI HC A15/MF A03

The basic concepts of the unified method needed by engineers in understanding the techniques for incorporating aeroelastic effects in stability analyses of winged aircraft are presented, and practical procedures for performing such analyses are given. Kernel functions and operators are discussed. Within the framework of structural analyses, the conduction of vibration and static deflection analyses are considered. That aspect of Lagrange's equations of motion involving the external part of the system, the aerodynamics of the generalized forces and moments, are considered. The problem of determining the nature of the aerodynamic forces is discussed. These forces are independent of the static forces which are essential to keep the system in dynamic equilibrium. The forces considered maintain oscillations about this dynamic equilibrium state. The unified method is compared with the piston theory and it is found that the former is more accurate at low Mach numbers but is more restrictive with regards to the frequency. ESA

**N93-18177#** Naval Postgraduate School, Monterey, CA.
**VEHICLE GUIDANCE AND CONTROL ALONG CIRCULAR TRAJECTORIES M.S. Thesis**
Dimitrios A. Simakis Sep. 1992 82 p
(AD-A257570) Avail: CASI HC A05/MF A01

The problem of path keeping of marine vehicles along curved paths is considered. In particular, we are concerned with circular arcs that join two consecutive straight line segments. This provides smooth path changes between one segment and the next, utilizing a purely geometric reference path construction. Pure pursuit guidance is coupled with orientation angle control law to ensure stability and accuracy. Sensitivity analysis with respect to inaccuracies in the knowledge of the vehicle hydrodynamic characteristics is performed. The results demonstrate the validity of this approach and offer a way to achieve accurate path keeping in confined spaces. GRA

**N93-18193#** Naval Postgraduate School, Monterey, CA.
**IDENTIFICATION AND CONTROL OF NON-LINEAR TIME-VARYING DYNAMICAL SYSTEMS USING ARTIFICIAL NEURAL NETWORKS Ph.D. Thesis**
Shahar Dror Sep. 1992 285 p
(AD-A257595) Avail: CASI HC A13/MF A03

Identification and control of non-linear dynamical systems is a very complex task which requires new methods. This research addresses the problem of emulation and control via the use of distributed parallel processing, namely artificial neural networks. Four models for describing non-linear MIMO dynamical systems are presented. Based on these models, combined feedforward and recurrent neural networks are structured to emulate the dynamical system. Further, a procedure to emulate multiple systems in a single network is suggested. A method for finding a minimal realization of a network is introduced. The minimization greatly reduces the complexity of the network without degrading the operating performance of the network. This work also examines the application of artificial neural networks for adaptive control. The multiple-system approach is used to find an adaptive neural network controller for non-linear MIMO time-varying system in a direct model reference control scheme. The controller network is trained using a procedure called back-propagation through the plant, which was extended in this work. The application of neural networks is demonstrated on a longitudinal model of the F/A-18A fighter aircraft, both with the undamaged aircraft and with the mechanism as a time-varying MIMO dynamical system. GRA

**N93-19019** Virginia Polytechnic Inst. and State Univ., Blacksburg.
**FORMULATION OF A STRUCTURAL MODEL FOR FLUTTER ANALYSIS OF LOW ASPECT RATIO COMPOSITE AIRCRAFT WINGS Ph.D. Thesis**
Timothy J. Seitz 1992 92 p
Avail: Univ. Microfilms Order No. DA9301017

The research contributes toward a fully integrated multidisciplinary wing design synthesis by development of an appropriate structural model. The goal is to bridge the gap between highly idealized structural beam/aerodynamic strip models and the very detailed finite element and computational fluid dynamics, FEM/CFD, techniques. The former provides insufficient accuracy for flutter analysis of modern low aspect ratio composite wings. The latter is too computationally intensive for use in the inner loop of a simultaneous multidisciplinary optimization problem. The derived model provides a useful preliminary design tool as well. Dissert. Abstr.

**N93-19095#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**STRATEGIES FOR OPTIMAL CONTROL DESIGN OF NORMAL ACCELERATION COMMAND FOLLOWING ON THE F-16 M.S. Thesis**
James C. Baird Dec. 1992 197 p
(AD-A258975; AFIT/GAE/ENY/92D-08) Avail: CASI HC A09/MF A03

Weight shapes and locations are investigated for H2, H-infinity, and the general mixed H2/H-infinity optimization methodologies. The design model is normal acceleration command following for the F-16 (SISO) at Mach 0.6 and Sea Level, which yields a nonminimum phase and unstable plant. H2 design types include LQG, LQG/Sensitivity, and LQG/Tracking. Robustness and tracking are the objectives of the central H-infinity process. Both H-infinity optimal and suboptimal controllers are examined, with the suboptimal controller shown as the practical choice for this plant. The mixed H2/H-infinity setup allows the tradeoff between H2 tracking and noise rejection, and H-infinity robustness. Results of weight choices on all designs are discussed, with the mixed H2/H-infinity design being favored. GRA

**N93-19102#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AUTOMATED CONTROL OF AIRCRAFT IN FORMATION FLIGHT M.S. Thesis**
Louis E. Buzogany 15 Dec. 1992 126 p
(AD-A259020; AFIT/GE/ENG/92D-07) Avail: CASI HC A07/MF A02

In this study, an automated formation control system for an aircraft formation comprised of one lead and multiple wing aircraft is analyzed. Second-order models of the C-130 aircraft are developed in order to accurately model the flying qualities of large aircraft. This automated formation control system is capable of controlling the C-130 aircraft in maneuvering formation flight, thus reducing the wing's pilot workload. During formation flight, the wing aircraft continuously measures the lead aircraft's relative position with an ideal on-board position sensor. This information, in addition to Proportional Plus Integral feedback control, is used to maintain the aircraft in formation. The control of each wing aircraft is assumed to be independent of other wing aircraft. Other than for nominal formation separation commands, no continuous communication is assumed between the formation aircraft. An analytical analysis of the formation control problem reveals that integral control is needed to achieve zero steady state error

in the separation distances (after a formation maneuver is executed). This conclusion is confirmed using computer simulations. An analytical method of selecting the Proportional Plus Integral parameters is developed by identifying the dominant system dynamics and residues of the step response. In an attempt to reduce the fuel consumption of the wing aircraft during formation heading change maneuvers, an alternate control system is designed to conserve the energy of the wing. The resulting automated formation control system effectively maintains the formation of aircraft through a combination of velocity, heading, and altitude changes. These is zero steady state error for all maneuvers and separation distance change responses. GRA

**N93-19105*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**CONCEPTS FOR PILOT INTERACTION WITH AN AUTOMATED NOE OBSTACLE-AVOIDANCE SYSTEM**

R. A. Coppenbarger and V. H. L. Cheng Dec. 1992 16 p
(RTOP 505-64-36)
(NASA-TM-103960; A-92157; NAS 1.15:103960) Avail: CASI HC A03/MF A01

The problem of providing an appropriate method by which a human pilot interacts with an automated nap-of-the-Earth rotorcraft guidance and control system is addressed. This problem is closely related to the broader question of what level and degree of automation is effective at reducing pilot workload during low-altitude flight missions requiring obstacle avoidance. A systematic approach for establishing the possible combinations of manual versus automatic authority over relevant guidance and control functions is first presented. From these possibilities, three candidate concepts are selected; selection is based upon their potential for practical implementation and reduction in pilot workload. This paper describes the selection of these three pilot-interaction concepts and the mathematical models for their implementation. Author

**N93-19108*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**LONGITUDINAL-CONTROL DESIGN APPROACH FOR HIGH-ANGLE-OF-ATTACK AIRCRAFT**

Aaron J. Ostroff and Melissa S. Proffitt (Lockheed Engineering and Sciences Co., Hampton, VA.) Washington Feb. 1993 29 p
(RTOP 505-64-30-01)
(NASA-TP-3302; L-17123; NAS 1.60:3302) Avail: CASI HC A03/MF A01

This paper describes a control synthesis methodology that emphasizes a variable-gain output feedback technique that is applied to the longitudinal channel of a high-angle-of-attack aircraft. The aircraft is a modified F/A-18 aircraft with thrust-vectored controls. The flight regime covers a range up to a Mach number of 0.7; an altitude range from 15,000 to 35,000 ft; and an angle-of-attack (alpha) range up to 70 deg, which is deep into the poststall region. A brief overview is given of the variable-gain mathematical formulation as well as a description of the discrete control structure used for the feedback controller. This paper also presents an approximate design procedure with relationships for the optimal weights for the selected feedback control structure. These weights are selected to meet control design guidelines for high-alpha flight controls. Those guidelines that apply to the longitudinal-control design are also summarized. A unique approach is presented for the feed-forward command generator to obtain smooth transitions between load factor and alpha commands. Finally, representative linear analysis results and nonlinear batch simulation results are provided. Author

**N93-19351#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**HELICOPTER FLIGHT CONTROL SYSTEM DESIGN USING THE LINEAR QUADRATIC REGULATOR FOR ROBUST EIGENSTRUCTURE ASSIGNMENT M.S. Thesis**

Dempsey D. Solomon Dec. 1992 98 p
(AD-A258904; AFIT/GAE/ENY/92D-17) Avail: CASI HC A05/MF A02

This thesis applied modern, multi-variable control design techniques, via a FORTRAN computer algorithm, to U.S. Army helicopter models in hovering flight conditions. Eigenstructure assignment and Linear Quadratic Regulator (LQR) theory are used to achieve enhanced closed loop performance and stability characteristics with full state feedback. The addition of cross coupling weights to the standard LQR performance index is specifically addressed. A desired eigenstructure is chosen with a goal of reduced pilot workload via performance qualities requirements. Cross coupling weighting is shown to provide greater flexibility in achieving a desired closed loop eigenstructure. While the addition of cross coupling weighting is shown to eliminate stability margin guarantees associated with LQR methods, the modified algorithm can achieve a closer match to a desired eigenstructure than previous versions of the program while maintaining acceptable stability characteristics. GRA

**N93-19380*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**AN EXPLORATORY INVESTIGATION OF THE FLIGHT DYNAMICS EFFECTS OF ROTOR RPM VARIATIONS AND ROTOR STATE FEEDBACK IN HOVER**

Robert T. N. Chen Sep. 1992 43 p Presented at the 18th European Rotorcraft Forum, Avignon, France, 15-18 Sep. 1992
(RTOP 505-59-36)
(NASA-TM-103968; A-92173; NAS 1.15:103968) Avail: CASI HC A03/MF A01

This paper presents the results of an analytical study conducted to investigate airframe/engine interface dynamics, and the influence of rotor speed variations on the flight dynamics of the helicopter in hover, and to explore the potential benefits of using rotor states as additional feedback signals in the flight control system. The analytical investigation required the development of a parametric high-order helicopter hover model, which included heave/yaw body motion, the rotor speed degree of freedom, rotor blade motion in flapping and lead-lag, inflow dynamics, a drive train model with a flexible rotor shaft, and an engine/rpm governor. First, the model was used to gain insight into the engine/drive train/rotor system dynamics and to obtain an improved simple formula for easy estimation of the dominant first torsional mode, which is important in the dynamic integration of the engine and airframe system. Then, a linearized version of the model was used to investigate the effects of rotor speed variations and rotor state feedback on helicopter flight dynamics. Results show that, by including rotor speed variations, the effective vertical damping decreases significantly from that calculated with a constant speed assumption, thereby providing a better correlation with flight test data. Higher closed-loop bandwidths appear to be more readily achievable with rotor state feedback. The results also indicate that both aircraft and rotor flapping responses to gust disturbance are significantly attenuated when rotor state feedback is used. Author

**N93-19454*#** North Carolina Agricultural and Technical State Univ., Greensboro. Controls and Guidance Group.

**CONTROLS AND GUIDANCE RESEARCH**

Abdollah Homaifar, DeRome Dunn, Yong-Duan Song, and Steven H.-Y. Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 16 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

**N93-19915#** British Aerospace Defence, Preston (England).

**IN-FLIGHT STRUCTURAL MODE EXCITATION SYSTEM FOR FLUTTER TESTING**

R. B. Ramsay *In* AGARD, Flight Testing Oct. 1992 20 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

**N93-19918#** National Research Council of Canada, Ottawa (Ontario).

**FLY-BY VOICE, A TECHNOLOGY DEMONSTRATION**

J. Murray Morgan and David R. Starks (Canadian Marconi Co. Ltd., Kanata, Ontario ) *In* AGARD, Flight Testing Oct. 1992 10 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A02/MF A04

# 09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

**N93-17875#** National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

**FLIGHT SIMULATION EVALUATION OF THE FLYABILITY OF CURVED MLS APPROACHES WITH WIDE-BODY AIRCRAFT**

L. J. J. Erkelens and J. H. vanDronkelaar 30 Jun. 1990 123 p Sponsored by Royal Netherlands Air Force, and FAA

(NLR-TP-90238-U; ETN-93-93319) Avail: CASI HC A06/MF A02

A flight simulator study concerning the evaluation of flight director flown curved Microwave Landing System (MLS) approach paths with a simulated wide body transport aircraft is described. Four curved approach paths, consisting of two straight segments and one 90 deg circular segment with different straight final segments lengths, were investigated. Moreover an MLS equivalent of the 13R Canarsie visual approach at Kennedy airport New York (U.S.) was considered. Test objectives were: to demonstrate the flybility of curved approaches for wide body type of aircraft; to collect scientific data on pilot performance and operational acceptance for manually flown (flight director aided) curved approaches; to determine the operationally acceptable minimum straight final segment length. Test conditions included various wind and visual conditions. Winds yielding limiting conditions for category 2 operations and winds providing airframe limiting conditions, as far as magnitude of cross/tailwind comments are concerned, were included. Visibility and cloud base conditions ranged from category 2 to better than category 1 conditions. Test data were obtained as subjective and objective results. Subjective results concern pilot questionnaire responses and pilot comments, while the objective results concern among other things path tracking accuracy, including isoprobability contour plots and touchdown performance. ESA

**N93-17986#** Federal Aviation Administration, Washington, DC. Office of Airport Planning and Programming.

**AN APPROACH TO AUTOMATED TERRAIN CLASSIFICATION FROM DIGITAL ELEVATION MODEL**

Linda H. Graff 23 Nov. 1992 11 p

(AD-A258210; TEC-R-195) Avail: CASI HC A03/MF A01

Using digital elevation model data, landforms are classified into two broad, generic terrain features--mounts and non-mounts. Mounts represents an aggregation of elevated features including hills, mountains, and ranges. All remaining features are classified collectively as non-mount. The results of this work suggest that it may be possible to acceptably replicate the manual classification of certain generic terrain features. However, the general utility of the mount/non-mount classification appears to be limited by the classification algorithms, the nature of the regional terrain and the quality of available digital data. Possible applications for generic terrain feature information, such as mounts and non-mounts, are presented. GRA

**N93-18520*#** MCAT Inst., San Jose, CA.

**STUDY OF OPTICAL TECHNIQUES FOR THE AMES UNITARY WIND TUNNEL, PART 7 Final Report**

George Lee Jan. 1993 12 p

(Contract NCC2-716)

(NASA-CR-192165; NAS 1.26:192165; MCAT-93-02) Avail: CASI HC A03/MF A01

A summary of optical techniques for the Ames Unitary Plan wind tunnels are discussed. Six optical techniques were studied: Schlieren, light sheet and laser vapor screen, angle of attack, model deformation, infrared imagery, and digital image processing. The study includes surveys and reviews of wind tunnel optical techniques, some conceptual designs, and recommendations for use of optical methods in the Ames Unitary Plan wind tunnels. Particular emphasis was placed on searching for systems developed for wind tunnel use and on commercial systems which could be readily adapted for wind tunnels. This final report is to summarize the major results and recommendations. Author

**N93-18766*#** MCAT Inst., San Jose, CA.

**STUDY OF OPTICAL TECHNIQUES FOR THE AMES UNITARY WIND TUNNEL: DIGITAL IMAGE PROCESSING, PART 6**

George Lee Jan. 1993 38 p

(Contract NCC2-716)

(NASA-CR-192164; NAS 1.26:192164; MCAT-92-021) Avail: CASI HC A03/MF A01

A survey of digital image processing techniques and processing systems for aerodynamic images has been conducted. These images covered many types of flows and were generated by many types of flow diagnostics. These include laser vapor screens, infrared cameras, laser holographic interferometry, Schlieren, and luminescent paints. Some general digital image processing systems, imaging networks, optical sensors, and image computing chips were briefly reviewed. Possible digital imaging network systems for the Ames Unitary Wind Tunnel were explored. Author

**N93-19280#** National Aerospace Lab., Tokyo (Japan).

**RAREFIED GAS NUMERICAL WIND TUNNEL. PART 7: OREX [KIHAKU KITAI SUUCHI FUUDOU. 7: OREX]**

Katsuhisa Koura and Mikinari Takahira (Daiko Ltd., Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 37-40 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A01/MF A03

**N93-19288#** National Aerospace Lab., Tokyo (Japan).

**NUMERICAL WIND TUNNEL: REQUIREMENTS AND THE OUTLINE [SUUCHI FUUDOU: YOUKYUU YOUKEN TO GAIRYAKU]**

Hajime Miyoshi *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 91-97 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A02/MF A03

**N93-19289#** National Aerospace Lab., Tokyo (Japan).

**NUMERICAL WIND TUNNEL HARDWARE [SUUCHI FUUDOU NO HADOUEA]**

Hajime Miyoshi, Yoshiro Yoshioka (Fujitsu Ltd., Tokyo, Japan ), Masayuki Ikeda (Fujitsu Ltd., Tokyo, Japan ), and Moriyuki Takamura (Fujitsu Ltd., Tokyo, Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 99-106 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A02/MF A03

**N93-19290#** National Aerospace Lab., Tokyo (Japan).

**THE OPERATING SYSTEM FOR NUMERICAL WIND TUNNEL [SUUCHI FUUDOU NO OPERETEINGU SHISUTEMU]**

Masahiro Fukuda, Kazuyo Suematsu, Masako Tutiya, Akira Ozora (Fujitsu Ltd., Tokyo, Japan ), Takashi Kunai (Fujitsu Ltd., Tokyo, Japan ), and Yoshinori Sakamoto (Fujitsu Ltd., Tokyo, Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 107-113 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A02/MF A03

**N93-19291#** National Aerospace Lab., Tokyo (Japan).

**THE LANGUAGE PROCESSOR SYSTEM FOR THE NUMERICAL WIND TUNNEL [SUUCHI FUUDOU NO GENGO SHORI SOFUTOUEA]**

Masahiro Fukuda, Takashi Nakamura, Masahiro Yoshida, Shin Okada (Fujitsu Ltd., Tokyo, Japan ), and Syuichi Nakamura (Fujitsu Ltd., Tokyo, Japan ) *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 115-121 In JAPANESE (For primary document see N93-19273 06-02)

Avail: CASI HC A02/MF A03

**N93-19456*#** North Carolina Agricultural and Technical State Univ., Greensboro. Human-Machine Systems Engineering Group.

**FLIGHT SIMULATOR FOR HYPERSONIC VEHICLE AND A STUDY OF NASP HANDLING QUALITIES**

Celestine A. Ntuen, Eui H. Park, Joseph M. Deeb, and Jung H. Kim *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992

8 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

**N93-19706#** Concordia Univ., Montreal (Quebec). Dept of Mechanical Engineering.
**USE OF MICROPROCESSOR-BASED SIMULATOR TECHNOLOGY AND MEG/EEG MEASUREMENT TECHNIQUES IN PILOT EMERGENCY-MANOEUVER TRAINING**
J. V. Svoboda, Ruth M. Heron (Transportation Development Centre, Montreal, Quebec), and H. Weinberg (Simon Fraser Univ., Burnaby, British Columbia) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

## 12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

**N93-18022#** Army Command and General Staff Coll., Fort Leavenworth, KS. School of Advanced Military Studies.
**AN EVOLVING JOINT SPACE CAMPAIGN CONCEPT AND THE ARMY'S ROLE**
Henry G. Franke, III 29 May 1992 127 p
(AD-A258112) Avail: CASI HC A07/MF A02

This monograph examines the question of an evolving joint space campaign concept and the Army's role in it over the next 20 years. Analysis progresses logically through a series of topics in order to arrive at a complete picture of this evolutionary space campaign concept, as well as the Army's place in it. Space plays an increasingly important role in US military operations, particularly when tied together with advances in information management. The synergistic impact due to the combination of these two areas suggests a revolution in the nature of modern warfare which saw its emergence during the 1991 Gulf War. With this theme in mind, I review the Army's roles, missions, and historical involvement in space, then present technological opportunities and a perspective on investment strategies for military space. A detailed discussion of a near-term military space theory and current space doctrines supports the need for an accepted military space theory as a foundation for Joint and Service space doctrines, space campaign design and conduct, and space force generation. The basis for such a theory is established using Julian Corbett's maritime warfare theory as a point of departure, while recognizing that space as a unique military operating medium requires its own theory and a regime to govern the application of space forces. GRA

**N93-18219#** Air War Coll., Maxwell AFB, AL.
**SPACE IS A DIFFERENT PLACE**
Gordon R. Middleton 5 May 1992 13 p
(AD-A258336) Avail: CASI HC A02/MF A01

U.S. Air Force policy is that 'space is a place' not a mission, and second, that air and space (aerospace) constitute a single environment. The U.S. Air Force has implemented this policy in both its organizations and doctrine. The creation of the Air Force Space Command translated this policy into Air Force organization. The recently published 1992 edition of the Air Force Manual 1-1, Basic Aerospace Doctrine of the U.S. Air Force, incorporates this policy into doctrine. The second policy from above is more an issue of physics than politics and is, therefore, amenable to objective discussion and is discussed. Rationale in AFM 1-1 for treating air and space as a single environment is analyzed and the nature of the air and space environments are further examined through the lens of characteristics of air power. The purpose in comparing the air and space environments is to help Air Force users of space systems and those making decisions on space systems to avoid the mistake, common even among space advocates, of merely replacing 'air' with 'aerospace' in discussions of doctrine, requirements, and operations. The ultimate goal of this paper is to advance discussion and understanding of space and space systems. The conclusion is not that air and space have nothing in common, but rather that AFM 1-1 does not substantiate its assertion that air and space constitute a single environment. Author

**N93-18267#** Air War Coll., Maxwell AFB, AL.
**EXPLORATION OF THE UTILITY OF MILITARY MAN IN SPACE IN THE YEAR 2025**
Daniel L. Hansen Mar. 1992 36 p
(AD-A258378) Avail: CASI HC A03/MF A01

It is absolutely essential for the well being of today's space forces as well as the future space forces of 2025, that DOD develop manned advanced technology space systems in lieu of or in addition to unmannned systems to effectively utilize mulitary man's compelling and aggressive warfighting abilities to accomplish the critical wartime mission elements of space control and force application. National space policy, military space doctrine and common all dictate they should do so if space superiority during future, inevitable conflict with enemy space forces is the paramount objective. Deploying military man in space will provide that space superiority and he will finally become the 'center of gravity' of the U.S. space program. Author

**N93-18544*#** National Aeronautics and Space Administration, Washington, DC.
**SPACE PHYSICS STRATEGY: IMPLEMENTATION STUDY. VOLUME 2: PROGRAM PLAN**
Apr. 1991 79 p Workshop 2 held in Bethesda, MD, 18-21 Jun. 1990 LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by color photographs Original contains color illustrations
(NASA-TM-108143; NAS 1.15:108143) Avail: CASI HC A05/MF A01; 17 functional color pages

In June, 1989, the Space Science and Applications Advisory Committee (SSAAC) authorized its Space Physics Subcommittee (SPS) to prepare a plan specifying the future missions, launch sequence, and encompassing themes of the Space Physics Division. The plan, now complete, is the product of a year-long study comprising two week-long workshops - in January and June 1990 - assisted by pre-workshop, inter-workshop, and post-workshop preparation and assessment activities. The workshops engaged about seventy participants, drawn equally from the Division's four science disciplines: cosmic and heliospheric physics, solar physics, magnetosphere physics, and ionosphere-thermosphere-mesospheric physics. An earlier report records the outcome of the first workshop; this is the report of the final workshop. Author

**N93-18562*#** National Aeronautics and Space Administration, Washington, DC.
**FUTURE NASA SOLAR SYSTEM EXPLORATION ACTIVITIES: A FRAMEWORK FOR INTERNATIONAL COOPERATION**
Bevan M. French, Terri Ramlose (Science Applications International Corp., Schaumburg, IL.), and Geoffrey A. Briggs (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 273-292 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

**N93-18636*#** National Aeronautics and Space Administration, Washington, DC.
**TRANSPORTATION AND PLATFORMS PERSPECTIVE**
Gary L. Bennett *In* NASA, Lewis Research Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 41-51 (For primary document see N93-18635 06-75)
Avail: CASI HC A03/MF A02

**N93-19124*#** National Optical Astronomy Lab. Tucson, AZ.
**LOW COST MISSIONS TO EXPLORE THE DIVERSITY OF NEAR EARTH OBJECTS**
Michael J. S. Belton and Alan Delamere (Ball Aerospace Systems Div., Boulder, CO.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 49-55 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

# 13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

**N93-18785#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Lampoldshausen (Germany). Inst. fuer Chemische Antriebe und Verfahrenstechnik.
**IMPROVED METHODS FOR REUSABLE AEROCLASSIFIED ORBITAL TRANSFER VEHICLE OPTIMIZATION Ph.D. Thesis - Tech. Univ. Berlin [PROBLEMLOESUNGEN FUER DIE LEISTUNGSOPTIMIERUNG WIEDERVERWENDBARER ATMOSPHAERENGESTUETZTER ORBITTRANSFERSYSTEME]**
Alf Daum Nov. 1991 149 p In GEORGIAN
(DLR-FB-91-41; ETN-93-91930) Avail: CASI HC A07/MF A02

Different configurations of Aeroassisted Orbital Transfer Vehicles (AOTV) are investigated in the context of their performance potential. Evaluating the performance of a candidate vehicle takes into consideration the efficiency of trajectory maneuvers as well as the loads acting on the vehicle. To carry out the vehicle analysis, a computer program was developed which is capable of calculating the complete exo/endoatmospheric optimal trajectory of an AOTV. In addition to the comparative evaluation of different vehicle configurations, special interest is given to the sensitivities of vehicle performance due to inaccuracies in the physical models. For this purpose, different models were used to describe atmospheric deviations or aerodynamic uncertainties in a more or less realistic way. Graphics illustrating the complex interdependencies between trajectory optimization, state and control variables, and other parameters of influence are included. ESA

**N93-18894#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DATA REDUCTION WITH LEAST SQUARES DIFFERENTIAL CORRECTION USING EQUINOCTIAL ELEMENTS M.S. Thesis**
Michael S. Wasson Dec. 1992 147 p
(AD-A259004; AFIT/GA/ENY/92D-15) Avail: CASI HC A07/MF A02

This study investigates earth satellite orbit estimation on a track of range, azimuth, and elevation data from a single tracking station. The estimation routine is a least squares batch filter based solely on two-body orbital motion. Using equinoctial elements for the reference orbit avoids the numerical difficulties of the classical elements at eccentricities near zero and inclinations near zero or 90 degrees. Orbits for Mir, DMSP, Explorer, Cosmos, and GPS are investigated. The goal of this study is to reduce orbit information from observations (range, azimuth, and elevation) to an element set and a covariance matrix without considering perturbation effects. The results indicate that the lower orbiting earth satellites had large J2 perturbations on the equinoctial elements causing the differential corrector to diverge. Higher orbiting satellites had minimal J2 effects and the correction process sufficiently extracted all information from the data and successfully reduced the observations to an element set and a covariance matrix. GRA

**N93-18899*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PRECISION X-BAND RADIO DOPPLER AND RANGING NAVIGATION: MARS OBSERVER INTERPLANETARY CRUISE SCENARIO**
J. A. Estefan and S. W. Thurman *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 11-22 (For primary document see N93-18897 06-32)
(RTOP 310-10-63-50)
Avail: CASI HC A03/MF A03

**N93-19214*#** Lowell Observatory, Flagstaff, AZ.
**ASTEROID ORBITAL ERROR ANALYSIS: THEORY AND APPLICATION**
K. Muinonen and Edward Bowell *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 429-432 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19215*#** Tokyo Astronomical Observatory, Mitaka (Japan). National Astronomical Observatory.
**LONG-TERM ORBITAL EVOLUTION OF SHORT-PERIOD COMETS FOUND IN PROJECT COSMO-DICE**
Tsuko Nakamura and Makoto Yoshikawa (Ministry of Posts and Telecommunications, Kashima, Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 433-438 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

**N93-19242*#** Academy of Sciences (USSR), Perm. Inst. of Theoretical Astronomy.
**ON THE DISTRIBUTION OF MINOR PLANET INCLINATIONS**
Viktor A. Shor and Eleonora I. Yagudina *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 553-556 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19254*#** Polish Academy of Sciences, Warsaw. Space Research Centre.
**DETERMINATION OF ORBITS OF COMETS: P/KEARNS-KWEE, P/GUNN, INCLUDING NONGRAVITATIONAL EFFECTS IN THE COMETS' MOTION**
Bozenna Todorovic-Juchniewicz and Grzegorz Sitarski *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 605-608 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19414*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.
**PRECISE TRACKING OF THE MAGELLAN AND PIONEER VENUSORBITERS BY SAME-BEAM INTERFEROMETRY. PART 1: DATAACCURACY ANALYSIS**
J. S. Border, W. M. Folkner, R. D. Kahn, and K. S. Zukor *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 1-20 (For primary document see N93-19413 06-32)
(RTOP 310-10-60-91-01)
Avail: CASI HC A03/MF A03

**N93-19415*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Navigation Systems Section.
**APPLICATION OF HIGH-PRECISION TWO-WAY RANGING TO GALILEO EARTH-1 ENCOUNTER NAVIGATION**
V. M. Pollmeier and S. W. Thurman *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 21-32 (For primary document see N93-19413 06-32)
(RTOP 310-10-63-84-02)
Avail: CASI HC A03/MF A03

**N93-19419*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Navigation Systems Section.
**USE OF THE VLBI DELAY OBSERVABLE FOR ORBIT DETERMINATION OF EARTH-ORBITING VLBI SATELLITES**
J. S. Ulvestad *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 77-91 (For primary document see N93-19413 06-32)
(RTOP 310-10-63-50-00)
Avail: CASI HC A03/MF A03

# 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

**N93-18084#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**RANGE SCHEDULING AUTOMATION FOR THE AIR FORCE SATELLITE CONTROL NETWORK: A CASE STUDY IN COMPUTER SYSTEM DEVELOPMENT M.S. Thesis**
Donald J. Aitken and Steven C. Bishop Sep. 1992 164 p
(AD-A258142; AFIT/GSM/LSY/92S-1) Avail: CASI HC A08/MF A02

The factors influencing divergent outcomes of two computer system development efforts which were undertaken to fulfill the same requirement

for computer automation of a manual resource scheduling process were explored. The first project employed the traditional waterfall approach to system development, but resulted in user rejection and cancellation after considerable resources and effort had been expended. The second project employed prototyping and both the process and the product were well received by the users and ultimately produced an operational system. Analysis yielded eight contributory factors to the failure of the first effort. Three of these were related to the waterfall approach, but the remaining five would have adversely affected any type of development effort. As a result, the waterfall approach was not deemed to be the most significant contributor to the failure. However, the major contributor to the success of the second effort was the use of prototyping. Most theoretical advantages of prototyping over the waterfall approach were observed in that effort and two additional advantages were identified. Prototyping's disadvantages were largely mitigated by strong management control of the development process. GRA

**N93-19363#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**OPTIMAL CONTROL OF THE STARFIRE BEAM DIRECTOR M.S. Thesis**

Troy V. Lanier Dec. 1992 264 p

(AD-A258839; AFIT/GAE/ENY/92D-16) Avail: CASI HC A12/MF A03

The Starfire Beam Director (SBD) is located at the Starfire Optical Range at Kirtland Air Force Base in Albuquerque, New Mexico. The SBD capabilities include tracking celestial objects and active or passive tracking of artificial satellites to support the Phillips Laboratory Ground Based Laser Acquisition, Tracking, and Pointing (GBL ATP) program. The pointing and tracking accuracy needed to support such experiments is micron rad to sub-grad level. To accomplish this goal requires precise pointing of the massive 6 ton 1-meter clear aperture coelostat. Optimal control design techniques are used to develop a controller to meet the stringent pointing requirements. A nominal linear state-space model was built which included gimbal dynamics, plant disturbances, and sensor noise. Then optimal control design techniques were used to develop unity feedback and two degree of freedom controllers. The various controllers were simulated with the coelostat truth model, which incorporated the higher frequency control loop and motor dynamics, nonlinearities, plant disturbances, sensor noise, and discrete control effects. The best of the designs, the H2 unity feedback controller, was compared and contrasted with the performance of the controller currently being used, which was obtained by classical control design. The H2 controller exceeded tracking requirements and in most areas performed better than the current controller. GRA

**N93-18843*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**DYNAMIC TEST RESULTS FOR THE CASES GROUND EXPERIMENT**

Angelia P. Bukley, Alan F. Patterson, and Victoria L. Jones (Logicon Control Dynamics Co., Huntsville, AL.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 359-366 (For primary document see N93-18818 06-18)

Avail: CASI HC A02/MF A04

## 15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

**N93-18067*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**SPACE SHUTTLE SOLID ROCKET BOOSTER MAIN PARACHUTE DAMAGE REDUCTION TEAM REPORT**

G. Watts Washington Jan. 1993 93 p

(NASA-TM-4437; M-706; NAS 1.15:4437) Avail: CASI HC A05/MF A01

This report gives the findings of the space shuttle solid rocket booster main parachute damage reduction team. The purpose of the team was to investigate the causes of main parachute deployment damage and to recommend methods to eliminate or substantially reduce the damage. The team concluded that the two primary causes of significant damage during deployment are vent entanglement and contact of the parachutes with the main parachute support structure. As an inexpensive but effective step towards damage reduction, the team recommends modification of the parachute packing procedure to eliminate vent entanglement. As the most effective design change, the team recommends a pilot chute-deployed soft-pack system. Alternative concepts are also recommended that provide a major reduction in damage at a total cost lower than the pilot chute-deployed soft pack. Author

**N93-18083#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.

**PUBLIC SPACE LAUNCH ACQUISITION: A COMPARATIVE CASE STUDY M.S. Thesis**

Kenneth R. Leeson and Lee W. Rosen Sep. 1992 139 p

(AD-A258141; AFIT/GCM/LSP/92S-7) Avail: CASI HC A07/MF A02

Three commonly practiced approaches to government acquisition of space launch services are analyzed. These approaches are employed by the U.S. Air Force, the National Aeronautics and Space Administration, and the Strategic Defense Initiative Organization. The literature review provides a comprehensive overview of the commercial space launch industry and details critical perspectives on commercial launch. Launch contracts which were representative of each organization's acquisition procedures were investigated and evaluated along several critical issues and elements of the space launch acquisition process. These issues included payload characteristics, government oversight, contractor incentives, insurance, liability, and cost. The critical issues and elements were determined by using the Delphi method to survey 25 experts in the space launch field. Archival contractual data from the three government agencies were obtained and found many inconsistencies among the different agencies' acquisition procedures. The thesis ends with a recommendation for a hybrid acquisition approach encompassing the strengths of the three cases. GRA

**N93-18141*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**SYSTEMS DESIGN ANALYSIS APPLIED TO LAUNCH VEHICLE CONFIGURATION**

R. Ryan and V. Verderaime Jan. 1993 37 p

(NASA-TP-3326; M-709; NAS 1.60:3326) Avail: CASI HC A03/MF A01

As emphasis shifts from optimum-performance aerospace systems to least lift-cycle costs, systems designs must seek, adapt, and innovate cost improvement techniques in design through operations. The systems design process of concept, definition, and design was assessed for the types and flow of total quality management techniques that may be applicable in a launch vehicle systems design analysis. Techniques discussed are task ordering, quality leverage, concurrent engineering, Pareto's principle, robustness, quality function deployment, criteria, and others. These cost oriented techniques are as applicable to aerospace systems design analysis as to any large commercial system. Author

**N93-18170*#** National Aeronautics and Space Administration, Washington, DC.

**LAUNCH SYSTEM DEVELOPMENT IN THE PACIFIC RIM**

Barbara A. Stone and John R. Page (New South Wales Univ., Kensington, Australia ) 1993 9 p Proposed for presentation at the Thirtieth Space Congress, Cocoa Beach, FL, 27-30 Apr. 1993

(NASA-TM-108595; NAS 1.15:108595) Avail: CASI HC A02/MF A01

Several Western Pacific Rim nations are beginning to challenge the domination of the United States, Europe, and the former Soviet Union in the international market for commercial launch sevices. This paper examines the current development of launch systems in China, Japan, and Australia. China began commercial launch services with their Long March-3 in April 1990, and is making enhancements to vehicles in this family. Japan is developing the H-2 rocket which will be marketed on a commercial basis. In Australia, British Aerospace Ltd. is leading a team conducting a project definition study for an Australian Launch Vehicle, aimed at launching the new generation of satellites into low Earth orbit. I.I.C.

**N93-18300#** Naval Surface Warfare Center, Dahlgren, VA.

**STRUCTURAL PERFORMANCE OF CANDIDATE ABLATIVES FOR UPTAKE SECTION OF VERTICAL LAUNCHING SYSTEM**

John W. Powers Oct. 1992 98 p

(AD-A258218; NSWCDD/TR-92/477) Avail: CASI HC A05/MF A02

The structural performance of several candidate ablatives for the uptake section of the Navy's Vertical Launching System is investigated. The uptake is modeled using a fixed-fixed beam-loaded by a uniform pressure. Beam displacement field equations are solved, assuming that the ablatives exhibit bimodular behavior in tension and compression. The candidate ablatives are ranked according to predicted structural performance. The current uptake ablative, MXBE-350, possesses the highest factor of safety in this analysis, although all but one of the ablatives considered appears to be acceptable. Additionally, the effects of erosion on the magnitudes of the peak stresses seen by the virgin ablatives are analyzed by varying the thickness of the ablatives in the uptake. As the thickness of the ablative decreases, the peak stresses in the ablative decrease. Finally, the effect of the stiffness of the ablative on predicted stresses in the adhesive layer is computed. As the elastic modulus of the ablative increases, the stresses in the adhesive decrease. GRA

**N93-18865#** Space Policy Advisory Board, Washington, DC.
**THE FUTURE OF THE US SPACE LAUNCH CAPABILITY**
Nov. 1992 47 p
Avail: CASI HC A03/MF A01

On 24 Jul. 1991, the President approved a National Space Launch Strategy. The fundamental purpose of the Task Group was to review progress on implementation of the National Space Launch Strategy, to look broadly at launch activities, and, as a minimum, address the following issues: (1) actions that have been taken or are being planned to assure that current launch systems and infrastructure remain capable of meeting U.S. launch needs into the early years of the next decade; (2) progress on New Launch System (NLS) development including management arrangements, system design considerations, and performance projections; (3) plans for the transition of unmanned payloads from current systems to NLS; (4) planned investments in aerospace transportation technology; (5) plans for continuing human space flight into the early 21st century; (6) plans for the possible use of excess ballistic missiles for space launch; and (7) current and planned activities implementing the policy goal of actively considering commercial space launch needs. The findings from the review are summarized and recommendations to satisfy space launch objectives and to fully implement the space launch strategy are provided. Author

**N93-18872*#** MCAT Inst., San Jose, CA.
**DEVELOPMENT OF COMPUTATIONAL METHODS FOR HEAVY LIFT LAUNCH VEHICLES Progress Report**
Seokkwan Yoon and James S. Ryan Feb. 1993 46 p
(Contract NCC2-505)
(NASA-CR-192298; NAS 1.26:192298; MCAT-93-03) Avail: CASI HC A03/MF A01

The research effort has been focused on the development of an advanced flow solver for complex viscous turbulent flows with shock waves. The three-dimensional Euler and full/thin-layer Reynolds-averaged Navier-Stokes equations for compressible flows are solved on structured hexahedral grids. The Baldwin-Lomax algebraic turbulence model is used for closure. The space discretization is based on a cell-centered finite-volume method augmented by a variety of numerical dissipation models with optional total variation diminishing limiters. The governing equations are integrated in time by an implicit method based on lower-upper factorization and symmetric Gauss-Seidel relaxation. The algorithm is vectorized on diagonal planes of sweep using two-dimensional indices in three dimensions. A new computer program named CENS3D has been developed for viscous turbulent flows with discontinuities. Details of the code are described in Appendix A and Appendix B. With the developments of the numerical algorithm and dissipation model, the simulation of three-dimensional viscous compressible flows has become more efficient and accurate. The results of the research are expected to yield a direct impact on the design process of future liquid fueled launch systems. Author

**N93-18950#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ANALYSIS OF TITAN 4 LAUNCH RESPONSIVENESS M.S. Thesis**
Michael T. Dunn Dec. 1992 104 p
(AD-A259021; AFIT/GSO/ENS/92D-05) Avail: CASI HC A06/MF A02

The feasibility of developing responsive space systems through responsive launch operations with the Titan 4, the only expendable heavy-lift launch vehicle in the United States inventory, is investigated. A definition for responsive launch has not been firmly established by Air Force Space Command for this launch vehicle. For benchmark purposes, the responsive launch definition contained in the proposal request for the Medium Launch Vehicle 3: launch vehicle ignition within 60 days of mission need notification is used. Titan 4 launch processing at Cape Canaveral Air Force Station (CCAFS), Florida currently requires in excess of six months, rendering Titan 4 launch operations non-responsive. A Top-Down analysis of Titan 4 launch processing at CCAFS is conducted to expose those factors which contribute to its current total duration. The factors considered are the time required for the assembly, testing, and transshipment activities associated with Titan 4 launch operations. Analysis of improvements in these activities estimates their effect on Titan 4 responsiveness. A Titan 4 responsive launch capability may be attainable with improvements in processing activities, with a new launch processing concept of preprocessing, or with a combination of both. GRA

**N93-19375*#** National Aeronautics and Space Administration, Washington, DC.
**EXPENDABLE LAUNCH VEHICLES TECHNOLOGY: A REPORT TO THE US SENATE AND THE US HOUSE OF REPRESENTATIVES**
Jul. 1990 47 p
(NASA-TM-108141; NAS 1.15:108141) Avail: CASI HC A03/MF A01

As directed in Public Law 100-657, Commercial Space Launch Act Amendments of 1988, and consistent with National Space Policy, NASA has prepared a report on a potential program of research on technologies to reduce the initial and recurring costs, increase reliability, and improve performance of expendable launch vehicles for the launch of commercial and government spacecraft into orbit. The report was developed in consultation with industry and in recognition of relevant ongoing and planned NASA and DoD technology programs which will provide much of the required launch systems technology for U.S. Government needs. Additional efforts which could be undertaken to strengthen the technology base are identified. To this end, focus is on needs for launch vehicle technology development and, in selected areas, includes verification to permit private-sector new technology application at reduced risk. If such a program were to be implemented, it would entail both government and private-sector effort and resources. The additional efforts identified would augment the existing launch vehicle technology programs. The additional efforts identified have not been funded, based upon agency assessments of relative priority vis-a-vis the existing programs. Throughout the consultation and review process, the industry representatives stressed the overriding importance of continuing the DoD/NASA Advanced Launch Development activity and other government technology programs as a primary source of essential launch vehicle technology. Author

**N93-19496#** Illinois Univ., Urbana. Fusion Technology Lab.
**APPLICATION OF RAILGUN PRINCIPLE TO HIGH-VELOCITY HYDROGEN PELLET INJECTION FOR MAGNETIC FUSION REACTOR FUELING**
K. Kim and J. Zhang 1992 40 p
(Contract DE-FG02-84ER-52111)
(DE93-004563; DOE/ER-52111/5) Avail: CASI HC A03/MF A01

Three separate papers are included which report research progress during this period. Topics covered include: (1) a new railgun configuration with perforated sidewalls, (2) development of a fuseless small-bore railgun for injection of high-speed hydrogen pellets into magnetically confined plasmas, and (3) controls and diagnostics on a fuseless railgun for solid hydrogen pellet injection. DOE

**N93-19401*#** Baylor Univ., Dallas, TX. Dept. of Engineering and Computer Science.
**AUTOMATICALLY CALIBRATING ADMITTANCES IN KATE'S AUTONOMOUS LAUNCH OPERATIONS MODEL**
Steve Morgan *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 319-362 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

# 16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

**N93-18447*#** Tennessee Univ. Space Inst., Tullahoma. Center for Space Transportation and Applied Research.

**DEVELOPMENT OF AN INTELLIGENT HYPERTEXT MANUAL FOR THE SPACE SHUTTLE HAZARDOUS GAS DETECTION SYSTEM Semiannual Report, 1 Jul. - 31 Dec. 1992**

Ching F. Lo, George Z. Shi, Carl Bangasser, and Connie Fensky 1992 11 p

(Grant NAG8-835)

(NASA-CR-191898; NAS 1.26:191898) Avail: CASI HC A03/MF A01

A computer-based Integrated Knowledge System (IKS), the Intelligent Hypertext Manual (IHM), is being developed for the Space Shuttle Hazardous Gas Detection System (HGDS) at the Huntsville Operations Support Center (HOSC). The IHM stores all HGDS related knowledge and presents them in an interactive and intuitive manner. The IHM's purpose is to provide HGDS personnel with the capabilities of: enhancing the interpretation of real time data; recognizing and identifying possible faults in the Space Shuttle sub-system related to hazardous gas detections; locating applicable documentation related to procedures, constraints, and previous fault histories; and assisting in the training of personnel. Author

**N93-19050*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.

**DEBRIS/ICE/TPS ASSESSMENT AND INTEGRATED PHOTOGRAPHIC ANALYSIS FOR SHUTTLE MISSION STS-52 Final Report, 21 Oct. - 3 Nov. 1992**

Gregory N. Katnik, Scott A. Higginbotham, and J. Bradley Davis Dec. 1992 142 p Original contains color illustrations

(NASA-TM-107554; NAS 1.15:107554) Avail: CASI HC A07/MF A02; 61 functional color pages

A debris/ice/Thermal Protection System (TPS) assessment and integrated photographic analysis was conducted for Shuttle Mission STS-47. Debris inspections of the flight elements and launch pad were performed before and after launch. Ice/frost conditions on the external tank were assessed by the use of computer programs, nomographs, and infrared scanner data during cryogenic loading of the vehicle followed by on-pad visual inspection. High speed photography was analyzed after launch to identify ice/debris sources and evaluate potential vehicle damage and/or in-flight anomalies. This report documents the debris/ice/TPS conditions and integrated photographic analysis of Shuttle Mission STS-52, and the resulting effect on the Space Shuttle Program. Author

**N93-19494*#** National Aeronautics and Space Administration, Washington, DC.

**TOWARD A HISTORY OF THE SPACE SHUTTLE. AN ANNOTATED BIBLIOGRAPHY**

Roger D. Launius, comp. and Aaron K. Gillette, comp. Dec. 1992 100 p *Its* Studies in Aerospace History No. 1

(NASA-TM-108647; NAS 1.15:108647) Avail: CASI HC A05/MF A02

This selective, annotated bibliography discusses those works judged to be most essential for researchers writing scholarly studies on the Space Shuttle's history. A thematic arrangement of material concerning the Space Shuttle will hopefully bring clarity and simplicity to such a complex subject. Subjects include the precursors of the Space Shuttle, its design and development, testing and evaluation, and operations. Other topics revolve around the Challenger accident and its aftermath, promotion of the Space Shuttle, science on the Space Shuttle, commercial uses, the Space Shuttle's military implications, its astronaut crew, the Space Shuttle and international relations, the management of the Space Shuttle Program, and juvenile literature. Along with a summary of the contents of each item, judgments have been made on the quality, originality, or importance of some of these publications. An index concludes this work. Author

**N93-18936*#** Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.

**THE MIDDECK ACTIVE CONTROL EXPERIMENT (MACE)**

David W. Miller, Raymond B. Sepe, Daniel Rey, Erik Saarmaa, and Edward F. Crawley *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 551-565 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

**N93-19392*#** University of Central Florida, Orlando.

**HYDROGEN LEAK DETECTION IN THE SPACE SHUTTLE**

Ronald G Barile *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 31-68 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

# 17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

**N93-18703*#** Communications Satellite Corp., Clarksburg, MD.

**ON-BOARD B-ISDN FAST PACKET SWITCHING ARCHITECTURES. PHASE 1: STUDY Final Report**

Faris Faris, Thomas Inukai, Fred Lee, Dilip Paul, and Dong-Jye Shyy Jan. 1993 513 p

(Grant NAGw-4528)

(NASA-CR-189144; E-7561; NAS 1.26:189144) Avail: CASI HC A22/MF A04

Broadband ISDN (B-ISDN) extends the service integration concept to include future high speed, high volume network services as well as to accommodate narrowband ISDN in its infrastructure. The impact of B-ISDN services on satellite communications can be significant, requiring the same or similar quality of communications services provided by the terrestrial B-ISDN network. Potential satellite applications, alternate satellite network architectures, system design issues, and onboard switching/processing options for satellite B-ISDN services are investigated. Special attention is focused on fast packet switching architectures and switch design details to exploit the feasibility of implementing a fast packet switch in the future advanced communications satellite. Author

**N93-18777*#** New Mexico State Univ., Las Cruces. Center for Space Telemetering and Telecommunications Systems.

**TELEMETERING AND TELECOMMUNICATIONS RESEARCH Semiannual Status Report, Jan. - Jul. 1991**

William P. Osborne 1991 26 p

(Grant NAG5-1491)

(NASA-CR-191903; NAS 1.26:191903) Avail: CASI HC A03/MF A01

The research center activities during the reporting period have been focused in three areas: (1) developing the necessary equipment and test procedures to support the testing of 8PSK-TCM through TDRSS from the WSGT; (2) extending the theoretical decoder work to higher speeds with a design goal of 600MBPS at 2 bits/Hz; and (3) completing the initial phase of the CPFSK Multi-H research and determining what subsets (if any) of these coding schemes are useful in the TDRSS environment. The equipment for the WSGT TCM testing has been completed and is functioning in the lab at NMSU. Measured results to date indicate that the uncoded system with the modified HRD and NMSU symbol sync operates at 1 to 1.5 dB from theory when processing encoded 8PSK. The NMSU pragmatic decoder when combined with these units produces approximately 2.9 dB of coding gain at 10(exp -5) BER. Our study of CPFSK with Multi-H coding has reached a critical stage. The principal conclusions reached in this activity are: (1) no scheme using Multi-H alone investigated by us or found in the literature produces power/bandwidth trades that are as good as TCM with filtered 8PSK; (2) when Multi-H is combined with convolutional coding, one can obtain better coding gain than with Multi-H alone but still no better power/bandwidth performance than TCM and these gains are available

only with complex receivers; (3) the only advantage we can find for the CPFSK schemes over filtered MPSK with TCM is that they are constant envelope (however, constant envelope is of no benefit in a multiple access channel and of questionable benefit in a single access channel since driving the TWT to saturation in this situation is generally acceptable); and (4) based upon these results the center's research program will focus on concluding the existing CPFSK studies. Author

**N93-18854*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OPTICAL COMMUNICATIONS AND A COMPARISON OF OPTICAL TECHNOLOGIES FOR A HIGH DATA RATE RETURN LINK FROM MARS**
Rodney L. Spence Washington Jan. 1993 61 p
(RTOP 316-30-19)
(NASA-TP-3180; E-6030; NAS 1.60:3180) Avail: CASI HC A04/MF A01

The important principles of direct- and heterodyne-detection optical free-space communications are reviewed. Signal-to-noise-ratio (SNR) and bit-error-rate (BER) expressions are derived for both the direct-detection and heterodyne-detection optical receivers. For the heterodyne system, performance degradation resulting from received-signal and local oscillator-beam misalignment and laser phase noise is analyzed. Determination of interfering background power from local and extended background sources is discussed. The BER performance of direct- and heterodyne-detection optical links in the presence of Rayleigh-distributed random pointing and tracking errors is described. Finally, several optical systems employing Nd:YAG, GaAs, and CO2 laser sources are evaluated and compared to assess their feasibility in providing high-data-rate (10- to 1000-Mbps) Mars-to-Earth communications. It is shown that the root mean square (rms) pointing and tracking accuracy is a critical factor in defining the system transmitting laser-power requirements and telescope size and that, for a given rms error, there is an optimum telescope aperture size that minimizes the required power. The results of the analysis conducted indicate that, barring the achievement of extremely small rms pointing and tracking errors (less than 0.2 microrad), the two most promising types of optical systems are those that use an Nd:YAG laser (lambda = 1.064 microns) and high-order pulse position modulator (PPM) and direct detection, and those that use a CO2 laser (lambda = 10.6 microns) and phase shifting keying homodyne modulation and coherent detection. For example, for a PPM order of M = 64 and an rms pointing accuracy of 0.4 microrad, an Nd:YAG system can be used to implement a 100-Mbps Mars link with a 40-cm transmitting telescope, a 20-W laser, and a 10-m receiving photon bucket. Under the same conditions, a CO2 system would require 3-m transmitting and receiving telescopes and a 32-W laser to implement such a link. Other types of optical systems, such as a semiconductor laser systems, are impractical in the presence of large rms pointing errors because of the high power requirements of the 100-Mbps Mars link, even when optimal-size telescopes are used. Author

**N93-19441#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**SATCOM GENERAL PURPOSE MODEM DSCS 3 SCT BEACON TELEMETRY DISPLAY M.S. Thesis**
James D. Coppola Dec. 1992 210 p
(AD-A258849; AFIT/GE/ENG/92D-13) Avail: CASI HC A10/MF A03

This thesis documents the design and implementation of a DSCS 3 Single Channel Transponder (SCT) beacon telemetry display. The system is a personal computer based design which interfaces to three SCT beacon receiver/demodulators. The software was designed to decode and display both the DSCS 3 A and DSCS HI B satellite beacons. Recordings of the SCT beacon display can be made on paper and/or magnetic media when triggered by the user, a watchdog timer, or the SCT command accept telemetry bit. In addition, the system can be configured with an IRIG B Universal Time Coordinates (UTC) card which enables the software to determine the difference between the decoded SCT clock time and the local IRIG time source. Remoting the SCT configuration display is also possible using Hayes-compatible modems over a telephone link. GRA

**N93-18910*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE EFFECTS OF CORRELATED NOISE IN INTRA-COMPLEX DSN ARRAYS FOR S-BAND GALILEO TELEMETRY RECEPTION**
R. J. Dewey *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 129-152 (For primary document see N93-18897 06-32)
(RTOP 314-30-61-01-95)
Avail: CASI HC A03/MF A03

**N93-18911*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DEMONSTRATION OF A JOINT US-RUSSIAN VERY LONG BASELINE INTERFEROMETRY TRACKING CAPABILITY**
P. M. Kroger, B. A. Iijima, C. D. Edwards, V. Altunin (Academy of Sciences, USSR, Moscow ), V. Alexeev (Academy of Sciences, USSR, Moscow ), B. Lipatov (Academy of Sciences, USSR, Moscow ), and E. Molotov (Academy of Sciences, USSR, Moscow ) *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 153-166 (For primary document see N93-18897 06-32)
(RTOP 314-30-61-01-95)
Avail: CASI HC A03/MF A03

**N93-19429*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.
**CASCADED CONVOLUTIONAL CODES**
F. Pollara and D. Divsalar *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 202-207 (For primary document see N93-19413 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A02/MF A03

## 18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

**N93-17887*#** Naval Postgraduate School, Monterey, CA.
**SPACECRAFT DESIGN PROJECT: HIGH TEMPERATURE SUPERCONDUCTING INFRARED IMAGING SATELLITE**
18 Dec. 1991 285 p
(Contract NASw-4435)
(NASA-CR-192036; NAS 1.26:192036) Avail: CASI HC A13/MF A03

The High Temperature Superconductor Infrared Imaging Satellite (HTSCIRIS) is designed to perform the space based infrared imaging and surveillance mission. The design of the satellite follows the black box approach. The payload is a stand alone unit, with the spacecraft bus designed to meet the requirements of the payload as listed in the statement of work. Specifications influencing the design of the spacecraft bus were originated by the Naval Research Lab. A description of the following systems is included: spacecraft configuration, orbital dynamics, radio frequency communication subsystem, electrical power system, propulsion, attitude control system, thermal control, and structural design. The issues of testing and cost analysis are also addressed. This design project was part of the course Advanced Spacecraft Design taught at the Naval Postgraduate School. L.R.R.

**N93-17969*#** Naval Postgraduate School, Monterey, CA. Spacecraft Design Project Team.
**SPACECRAFT DESIGN PROJECT: LOW EARTH ORBIT COMMUNICATIONS SATELLITE**
Dave Moroney, Dave Lashbrook, Barry McKibben, Nigel Gardener, Thane Rivers, Greg Nottingham, Bill Golden, Bill Barfield, Joe Bruening, and Dave Wood et al Dec. 1991 325 p
(Contract NASw-4435)
(NASA-CR-192038; NAS 1.26:192038) Avail: CASI HC A14/MF A03

This is the final product of the spacecraft design project completed to fulfill the academic requirements of the Spacecraft Design and Integration 2 course (AE-4871) taught at the U.S. Naval Postgraduate School. The Spacecraft Design and Integration 2 course is intended to provide students detailed design experience in selection and design of both satellite system

and subsystem components, and their location and integration into a final spacecraft configuration. The design team pursued a design to support a Low Earth Orbiting (LEO) communications system (GLOBALSTAR) currently under development by the Loral Cellular Systems Corporation. Each of the 14 team members was assigned both primary and secondary duties in program management or system design. Hardware selection, spacecraft component design, analysis, and integration were accomplished within the constraints imposed by the 11 week academic schedule and the available design facilities. Author

**N93-17988*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**THE APPLICATION OF STRUCTURAL RELIABILITY TECHNIQUES TO PLUME IMPINGEMENT LOADING OF THE SPACE STATION FREEDOM PHOTOVOLTAIC ARRAY**

Isam S. Yunis and Kelly S. Carney 19 Apr. 1993 19 p Prepared for the 34th Structures, Structural Dynamics and Materials Conference, La Jolla, CA, 19-21 Apr. 1993; Cosponsored by the AIAA, ASME, ASCE, AHS, and ASC

(NASA-TM-105949; E-7468; NAS 1.15:105949; AIAA Paper 93-1338) Avail: CASI HC A03/MF A01

A new aerospace application of structural reliability techniques is presented, where the applied forces depend on many probabilistic variables. This application is the plume impingement loading of the Space Station Freedom Photovoltaic Arrays. When the space shuttle berths with Space Station Freedom it must brake and maneuver towards the berthing point using its primary jets. The jet exhaust, or plume, may cause high loads on the photovoltaic arrays. The many parameters governing this problem are highly uncertain and random. An approach, using techniques from structural reliability, as opposed to the accepted deterministic methods, is presented which assesses the probability of failure of the array mast due to plume impingement loading. A Monte Carlo simulation of the berthing approach is used to determine the probability distribution of the loading. A probability distribution is also determined for the strength of the array. Structural reliability techniques are then used to assess the array mast design. These techniques are found to be superior to the standard deterministic dynamic transient analysis, for this class of problem. The results show that the probability of failure of the current array mast design, during its 15 year life, is minute. Author

**N93-18004#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.

**INTERACTIVE SATELLITE NAVIGATION FOR THE NAVAL ENVIRONMENTAL OPERATIONAL NOWCASTING SYSTEM Final Report**

Christy L. Crosiar Jul. 1992 20 p

(AD-A257920; NOARL-48) Avail: CASI HC A03/MF A01

The capability of the Tactical Environmental Support System (TESS(3)) to acquire real-time satellite data led to a requirement to earth-locate the satellite data with a high degree of accuracy. After ingesting satellite data, the TESS(3) earth locates the data using an orbital prediction model, orbital elements, and an accurate time source. Because of limitations in the model, age of the elements, and time errors as large as 0.5 second, an interactive method was developed to correct navigated images with detectable errors. After reviewing existing methods, an interactive method was designed and developed for the user interface and computer hardware of TESS(3). The method incorporates a geographic data base, satellite imagery, an operator, and a mouse or trackball. The one rule for this method is that some visible land features occur in the Image. By using a trackball, the operator can position the geographic overlay onto features discernible on the image. The change in the geographic overlay is then used to correct the satellite navigation data so the current and subsequent retrievals can be extracted with the updated information. The procedure developed satisfies the Navy's requirement for accurate satellite navigation, and it is being implemented into the operational system. Newer procedures are planned that will eliminate most of the need for an operator by contrast processing the satellite image and then matching the image with a geographic data base. GRA

**N93-18116*#** Michigan Univ., Ann Arbor. Aerospace System Design.

**PROJECT APEX: ADVANCED PHOBOS EXPLORATION. MANNED MISSION TO THE MARTIAN MOON PHOBOS**

Apr. 1992 356 p Original contains color illustrations

(Contract NASw-4435)

(NASA-CR-192056; NAS 1.26:192056; Aero-483) Avail: CASI HC A16/MF A03; 2 functional color pages

The manned exploration of Mars is a massive undertaking which requires careful consideration. A mission to the moon of Mars called Phobos as a prelude to manned landings on the Martian surface offers some advantages. One is that the energy requirements, in terms of delta 5, is only slightly higher than going to the Moon's surface. Another is that Phobos is a potential source of water and carbon which could be extracted and processed for life support and cryogenic propellants for use in future missions; thus, Phobos might serve as a base for extended Mars exploration or for exploration of the outer planets. The design of a vehicle for such a mission is the subject of our Aerospace System Design course this year. The materials and equipment needed for the processing plant would be delivered to Phobos in a prior unmanned mission. This study focuses on what it would take to send a crew to Phobos, set up the processing plant for extraction and storage of water and hydrocarbons, conduct scientific experiments, and return safely to Earth. The size, configuration, and subsystems of the vehicle are described in some detail. The spacecraft carries a crew of five and is launched from low Earth orbit in the year 2010. The outbound trajectory to Mars uses a gravitational assisted swing by of Venus and takes eight months to complete. The stay at Phobos is 60 days at which time the crew will be engaged in setting up the processing facility. The crew will then return to Earth orbit after a total mission duration of 656 days. Both stellar and solar observations will be conducted on both legs of the mission. The design of the spacecraft addresses human factors and life science; mission analysis and control; propulsion; power generation and distribution; thermal control; structural analysis; and planetary, solar, and stellar science. A 0.5 g artificial gravity is generated during transit by spinning about the lateral body axis. Nuclear thermal rockets using hydrogen as fuel are selected to reduce total launch mass and to shorten the duration of the mission. The nuclear systems also provide the primary electrical power via dual mode operation. The overall spacecraft length is 110 meters and the total mass departing from low Earth orbit is 900 metric tons. Author

**N93-18154*#** Old Dominion Univ., Norfolk, VA.

**A METHODOLOGY FOR SELECTIVE REMOVAL OF ORBITAL DEBRIS**

R. L. Ash, P. J. ODonoghue, E. J. Chambers, and J. P. Raney (West Virginia Inst. of Tech., Montgomery.) 1992 14 p Conference held at World Space Congress, Washington, DC, 28 Aug. - 5 Sep. 1992

(Contract NASw-4435)

(NASA-CR-192052; NAS 1.26:192052) Avail: CASI HC A03/MF A01

Earth-orbiting objects, large enough to be tracked, were surveyed for possible systematic debris removal. Based upon the statistical collision studies of others, it was determined that objects in orbits approximately 1000 km above the Earth's surface are at greatest collisional risk. Russian C-1B boosters were identified as the most important target of opportunity for debris removal. Currently, more than 100 in tact boosters are orbiting the Earth with apogees between 950 km and 1050 km. Using data provided by Energia USA, specific information on the C-1B booster, in terms of rendezvous and capture strategies, was discussed. Author

**N93-18165*#** Texas Univ., Austin. Dept. of Aerospace Engineering.

**THE DESIGN OF A COMMON LUNAR LANDER Final Report**

Dan Driggers, Sean Hearrell, Kevin Key, Brian Le, Glen Love, Rob McMullen, Scott Messec, and Jim Ruhnke Dec. 1991 123 p

(Contract NASw-4435)

(NASA-CR-192026; NAS 1.26:192026) Avail: CASI HC A06/MF A02

The Austin Cynthesis Corporation was formed to respond to a Request for Proposal for the design of a Common Lunar Lander (CLL) capable of carrying lightweight (less than 500 kg), unspecified payload to the moon. This Final Design Report Document includes information on the requirements for the design project; the ideas proposed as solutions to the design problem; the work which has been completed in support of the design effort; justifications, validations, and verifications of decisions made during the project; and suggestions for future work to be done in support of the project. A project schedule, including current status of the items included on the schedule, as well as cost and management summaries is also included. Author

**N93-18167*#** Universities Space Research Association, Houston, TX. Advanced Design Program.

**LUNAR SCOUT: A PROJECT ARTEMIS PROPOSAL**

[1992] 105 p

(Contract NASw-4435)

(NASA-CR-192076; NAS 1.26:192076) Avail: CASI HC A06/MF A02

The results of a student project to design a lunar lander in the context of a specifically defined mission are presented. The Lunar Scout will be launched from Cape Canaveral, Florida onboard a Delta II launch vehicle. The Delta II will carry the lander and its payload to a 1367 km orbit. Once it reaches that altitude, a STAR 48A solid rocket motor will kick the spacecraft into a lunar trajectory. After burnout of the lunar insertion motor, it will be jettisoned from the spacecraft. The flight from the earth to the moon will take approximately 106.4 hours. During this time the battery, which was fully charged prior to launch, will provide all power to the spacecraft. Every hour, the spacecraft will use its sun sensors and star trackers to update its position, maintain some stabilization and relay it back to earth using the dipole antennas. At the start of its lunar trajectory, the spacecraft will fire one of its 1.5 N thrusters to spin in at a very small rate. The main reason for this is to prevent one side of the spacecraft from overheating in the sun. When the spacecraft nears the moon, it will orient itself for the main retro burn. At an altitude of 200 km, a 4400 N bipropellant liquid thruster will ignite to slow the spacecraft. During the burn, the radar altimeter will be turned on to guide the spacecraft. The main retro rocket will slow the lander to 10 m/s at an approximate altitude of 40 km above the moon. From there, the space craft will use four 4.5 N hydrazine vertical thrusters and 1.5 N horizontal thrusters to guide the spacecraft to a soft landing. Once on the ground, the lander will shutoff the radar and attitude control systems. After the debris from the impact has settled, the six solar panels will be deployed to begin recharging the batteries and to power up the payload. The feedhorn antenna will then rotate to fix itself on the earth. Once it moves, it will stay in that position for the spacecraft's lifetime. The payload will then be activated to begin the lunar mission. Author

**N93-18168*#** Ohio State Univ., Columbus. Dept. of Aeronautical and Astronautical Engineering.

**PROJECT WISH: THE EMERALD CITY, PHASE 3**

1992 194 p Original contains color illustrations

(Contract NASw-4435)

(NASA-CR-192081; NAS 1.26:192081) Avail: CASI HC A09/MF A03; 17 functional color pages

Phase 3 of Project Wish saw the evolution of the Emerald City (E-City) from a collection of specialized independent analyses and ideas to a working structural design integrated with major support systems and analyses. Emphasis was placed on comparing and contrasting the closed and open cycle gas core nuclear rocket engines to further determine the optimum propulsive system for the C-City. Power and thermal control requirements were then defined and the question of how to meet these requirements was addressed. Software was developed to automate the mission/system/configuration analysis so changes dictated by various subsystems constraints could be managed efficiently and analyzed interactively. In addition, the liquid hydrogen propellant tank was statically designed for minimum mass and shape optimization using a finite element modeling package called SDRC I-DEAS while spoke and shaft cross-sectional areas were optimized on ASTROS (Automated Structural Optimization System). A structural dynamic analysis also conducted using ASTROS enabled a study of the displacements, accelerations, modes and frequencies of the C-City. Finally, the attitude control system design began with an initial mass moment of inertia analysis and was then designed and optimized using linear quadratic regulator control theory. Author

**N93-18240#** Naval Postgraduate School, Monterey, CA.

**DESIGN OF MICROCONTROLLER SOFTWARE FOR A SATELLITE-BASED FERROELECTRIC CAPACITOR EXPERIMENT M.S. Thesis**

Terry G. Tutt Sep. 1992 98 p

(AD-A257960) Avail: CASI HC A05/MF A02

The Naval Postgraduate School's Space Systems Academic Group is developing a satellite-based experiment to evaluate the electrical properties of ferroelectric capacitors under high levels of ionizing particle radiation. The experiment, called FERRO, is one of three experiments that comprise the APEX mission. The APEX mission is sponsored by the joint Space Test Program and will be launched in early 1993. The main processor for FERRO is an Intel 80C196KB 16-bit embedded controller that will perform all aspects of experiment control, data acquisition, and communication with the host satellite processor. The design of systems and communications software to support the experiment is presented. Functional areas addressed by the design include: microcontroller and peripheral initialization; communication between the experiment and spacecraft processors; fault detection/recovery; recovery from loss of power and development of an IBM PC based program to provide for preflight verification, and testing of experiment hardware and software. GRA

**N93-18306#** Naval Postgraduate School, Monterey, CA.

**PACSIM: USING SIMULATION IN DESIGNING A COMMUNICATIONS SATELLITE M.S. Thesis**

Russell Gottfried Sep. 1992 88 p

(AD-A257857) Avail: CASI HC A05/MF A01

The Naval Postgraduate School is developing a small, experimental, low-orbit packet radio satellite for launch in 1995. It is the first for use by the amateur radio community to implement spread spectrum communications. To aid in designing the spacecraft's communications network, we have developed a packet-level, reusable, object-oriented simulation model, PACSIM, which performs the following functions: it fully emulates the activity of users in the network; and it has the ability to provide information on these measures in several thousand different scenarios. We describe this satellite-user network and elucidate the strong interdependence of design factors. Simulation results are presented. Also, we critique the use of simulation as a decision aid for assessing the effect of design decisions such as data transfer rate and spacecraft memory allocation for store-forward and capture. GRA

**N93-18322*#** SatCon Technology Corp., Cambridge, MA.

**DEVELOPMENT OF MAGNETOSTRICTIVE ACTIVE MEMBERS FOR CONTROL OF SPACE STRUCTURES Final Report, Jun. 1991 - Jul. 1992**

Bruce G. Johnson, Kevin M. Avakian, Ralph C. Fenn, Monique S. Gaffney, Michael J. Gerver, Timothy J. Hawkey, and Donald J. Boudreau 10 Aug. 1992 267 p

(Contract NAS7-1151; SBIR-04.14-0540)

(NASA-CR-190846; NAS 1.26:190846; R29-92) Avail: CASI HC A12/MF A03

The goal of this Phase 2 Small Business Innovative Research (SBIR) project was to determine the technical feasibility of developing magnetostrictive active members for use as truss elements in space structures. Active members control elastic vibrations of truss-based space structures and integrate the functions of truss structure element, actively controlled actuator, and sensor. The active members must control structural motion to the sub-micron level and, for many proposed space applications, work at cryogenic temperatures. Under this program both room temperature and cryogenic temperature magnetostrictive active members were designed, fabricated, and tested. The results of these performance tests indicated that room temperature magnetostrictive actuators feature higher strain, stiffness, and force capability with lower amplifier requirements than similarly sized piezoelectric or electrostrictive active members, at the cost of higher mass. Two different cryogenic temperature magnetostrictive materials were tested at liquid nitrogen temperatures, both with larger strain capability than the room temperature magnetostrictive materials. The cryogenic active member development included the design and fabrication of a cryostat that allows operation of the cryogenic active member in a space structure testbed. Author

**N93-18353*#** National Aeronautics and Space Administration, Washington, DC.

**SPACE STATION EVOLUTION: PLANNING FOR THE FUTURE**

Alphonso V. Diaz and Barbara S. Askins 23 Jun. 1987 7 p Submitted for publication

(NASA-TM-108596; NAS 1.15:108596) Avail: CASI HC A02/MF A01

The need for permanently manned presence in space has been recognized by the United States and its international partners for many years. The development of this capability was delayed due to the concurrent recognition that reusable earth-to-orbit transportation was also needed and should be developed first. While the decision to go ahead with a permanently

manned Space Station was on hold, requirements for the use of the Station were accumulating as ground-based research and the data from unmanned spacecraft sparked the imagination of both scientists and entrepreneurs. Thus, by the time of the Space Station implementation decision in the early 1980's, a variety of disciplines, with a variety of requirements, needed to be accommodated on one Space Station. Additional future requirements could be forecast for advanced missions that were still in the early planning stages. The logical response was the development of a multi-purpose Space Station with the ability to evolve on-orbit to new capabilities as required by user needs and national or international decisions, i.e., to build an evolutionary Space Station. Planning for evolution is conducted in parallel with the design and development of the baseline Space Station. Evolution planning is a strategic management process to facilitate change and protect future decisions. The objective is not to forecast the future, but to understand the future options and the implications of these on today's decisions. The major actions required now are: (1) the incorporation of evolution provisions (hooks and scars) in the baseline Space Station; and (2) the initiation of an evolution advanced development program. Author

**N93-18369#** European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).

**OLYMPUS: THE COMMUNICATIONS SATELLITE AND ITS USES. AN INTRODUCTION**

Norman Longdon, ed. Jan. 1991 6 p Original contains color illustrations

(ESA-F-29) Avail: CASI HC A02/MF A01

Olympus is the largest civil communications satellite ever launched. It is owned and operated by the European Space Agency (ESA) and is in a geostationary orbit at longitude 19 degrees W. Olympus was specifically designed to test the technologies needed for future satellite applications and services. However, capacity is also available to demonstrate new services via satellite such as tele-education and business communications. All the payloads are powerful enough to be used with very small earth stations. Olympus carries four quite distinct payloads, each with its own steerable antennas. The payloads are the (Direct) Broadcast Payload, the Specialized Services Payload, the 30/20 GHz Communications Payload, and the Propagation Payload. Various aspects of the services Olympus provides, how to use these services, and details on the payloads are presented. Author

**N93-18406*#** Alabama Univ., Huntsville.

**PREDICTING MULTI-WALL STRUCTURAL RESPONSE TO HYPERVELOCITY IMPACT USING THE HULL CODE**

William P. Schonberg Washington Jan. 1993 93 p

(Contract NAS8-36955)

(NASA-CR-4486; M-710; NAS 1.26:4486) Avail: CASI HC A05/MF A01

Previously, multi-wall structures have been analyzed extensively, primarily through experiment, as a means of increasing the meteoroid/space debris impact protection of spacecraft. As structural configurations become more varied, the number of tests required to characterize their response increases dramatically. As an alternative to experimental testing, numerical modeling of high-speed impact phenomena is often being used to predict the response of a variety of structural systems under different impact loading conditions. The results of comparing experimental tests to Hull Hydrodynamic Computer Code predictions are reported. Also, the results of a numerical parametric study of multi-wall structural response to hypervelocity cylindrical projectile impact are presented. Author

**N93-18818*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**THE FIFTH NASA/DOD CONTROLS-STRUCTURES INTERACTION TECHNOLOGY CONFERENCE, PART 1**

Jerry R. Newsom, comp. Washington Feb. 1993 416 p Conference held in Lake Tahoe, NV, 3-5 Mar. 1992

(RTOP 590-14-41-01)

(NASA-CP-3177-Pt-1; L-17174-Pt-1; NAS 1.55:3177-Pt-1) Avail: CASI HC A18/MF A04

This publication is a compilation of the papers presented at the Fifth NASA/DoD Controls-Structures Interaction (CSI) Technology Conference held in Lake Tahoe, Nevada, March 3-5, 1992. The conference, which was jointly sponsored by the NASA Office of Aeronautics and Space Technology and the Department of Defense, was organized by the NASA Langley Research Center. The purpose of this conference was to report to industry, academia, and government agencies on the current status of controls-structures interaction technology. The agenda covered ground testing, integrated design, analysis, flight experiments and concepts. For individual titles, see N93-18819 through N93-18846.

**N93-18819*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**THE MINI-MAST CSI TESTBED: LESSONS LEARNED**

Sharon E. Tanner, W. Keith Belvin, Lucas G. Horta, and R. S. Pappa *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 3-23 (For primary document see N93-18818 06-18)

Avail: CASI HC A03/MF A04

The Mini-Mast testbed was one of the first large scale Controls-Structure-Interaction (CSI) systems used to evaluate state-of-the-art methodology in flexible structure control. Now that all the testing at Langley Research Center has been completed, a look back is warranted to evaluate the program. This paper describes some of the experiences and technology development studies by NASA, university, and industry investigators. Lessons learned are presented from three categories: the testbed development, control methods, and the operation of a guest investigator program. It is shown how structural safety margins provided a realistic environment to simulate on-orbit CSI research, even though they also reduced the research flexibility afforded to investigators. The limited dynamic coupling between the bending and torsion modes of the cantilevered test article resulted in highly successful SISO and MIMO controllers. However, until accurate models were obtained for the torque wheel actuators, sensors, filters, and the structure itself, most controllers were unstable. Controls research from this testbed should be applicable to cantilevered appendages of future large space structures. Author

**N93-18820*#** Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.

**MODEL REDUCTION FOR THE DYNAMICS AND CONTROL OF LARGE STRUCTURAL SYSTEMS VIA NEUTRAL NETWORK PROCESSING DIRECT NUMERICAL OPTIMIZATION**

Georges A. Becus and Alistair K. Chan *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 25-33 (For primary document see N93-18818 06-18)

(Grant NAG3-1174)

Avail: CASI HC A02/MF A04

Three neural network processing approaches in a direct numerical optimization model reduction scheme are proposed and investigated. Large structural systems, such as large space structures, offer new challenges to both structural dynamicists and control engineers. One such challenge is that of dimensionality. Indeed these distributed parameter systems can be modeled either by infinite dimensional mathematical models (typically partial differential equations) or by high dimensional discrete models (typically finite element models) often exhibiting thousands of vibrational modes usually closely spaced and with little, if any, damping. Clearly, some form of model reduction is in order, especially for the control engineer who can actively control but a few of the modes using system identification based on a limited number of sensors. Inasmuch as the amount of 'control spillover' (in which the control inputs excite the neglected dynamics) and/or 'observation spillover' (where neglected dynamics affect system identification) is to a large extent determined by the choice of particular reduced model (RM), the way in which this model reduction is carried out is often critical. Author

**N93-18821*#** Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.

**PHYSICAL INSIGHT INTO THE SIMULTANEOUS OPTIMIZATION OF STRUCTURE AND CONTROL**

Robert N. Jacques and David W. Miller *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 35-46 (For primary document see N93-18818 06-18)

Avail: CASI HC A03/MF A04

Recent trends in spacecraft design which yield larger structures with

more stringent performance requirements place many flexible modes of the structure within the bandwidth of active controllers. The resulting complications to the spacecraft design make it highly desirable to understand the impact of structural changes on an optimally controlled structure. This work uses low structural models with optimal H(sub 2) and H(sub infinity) controllers to develop some basic insight into this problem. This insight concentrates on several basic approaches to improving controlled performance and how these approaches interact in determining the optimal designs. A numerical example is presented to demonstrate how this insight can be generalized to more complex problems. Author

**N93-18822*#** Phillips Lab., Edwards AFB, CA.
**SMART PATCH PIEZOCERAMIC ACTUATOR ISSUES** **c35**
Steven F. Griffin, Keith K. Denoyer, and Brad Yost *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 47-63 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

The Phillips Laboratory is undertaking the challenge of finding new and innovative ways to integrate sensing, actuation, and the supporting control and power electronics into a compact self-contained unit to provide vibration suppression for a host structure. This self-contained unit is commonly referred to as a smart patch. The interfaces to the smart patch will be limited to standard spacecraft power and possibly a communications line. The effort to develop a smart patch involves both contractual and inhouse programs which are currently focused on miniaturization of the electronics associated with vibrational control using piezoceramic sensors and actuators. This paper is comprised of two distinct parts. The first part examines issues associated with bonding piezoceramic actuators to a host structure. Experimental data from several specimens with varying flexural stiffness are compared to predictions from two piezoelectric/substructure coupling models, the Blocked Force Model and the Uniform Strain Model with Perfect Bonding. The second part of the paper highlights a demonstration article smart patch created using the insights gained from inhouse efforts at the Phillips Laboratory. This demonstration article has self contained electronics on the same order of size as the actuator powered by a voltage differential of approximately 32 volts. This voltage is provided by four rechargeable 8 volt batteries. Author

**N93-18823*#** Ohio Univ., Athens. Dept. of Electrical and Computer Engineering.
**A NUMERICAL APPROACH TO CONTROLLER DESIGN FOR THE ACES FACILITY**
W. Garth Frazier and R. Dennis Irwin *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 65-78 Sponsored by NASA. Marshall Space Flight Center and Ohio Aerospace Inst. (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

In recent years the employment of active control techniques for improving the performance of systems involving highly flexible structures has become a topic of considerable research interest. Most of these systems are quite complicated, using multiple actuators and sensors, and possessing high order models. The majority of analytical controller synthesis procedures capable of handling multivariable systems in a systematic way require considerable insight into the underlying mathematical theory to achieve a successful design. This insight is needed in selecting the proper weighting matrices or weighting functions to cast what is naturally a multiple constraint satisfaction problem into an unconstrained optimization problem. Although designers possessing considerable experience with these techniques have a feel for the proper choice of weights, others may spend a significant amount of time attempting to find an acceptable solution. Another disadvantage of such procedures is that the resulting controller has an order greater than or equal to that of the model used for the design. Of course, the order of these controllers can often be reduced, but again this requires a good understanding of the theory involved. Author

**N93-18824*#** Cincinnati Univ., OH. Dept. of Aerospace Engineering.
**MODEL REDUCTION RESULTS FOR FLEXIBLE SPACE STRUCTURES**
Trevor Williams and Masoud Mostarshedi *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 79-96 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

This paper describes the novel subsystem balancing technique for obtaining reduced-order models of flexible structures, and investigates its properties fully. This method can be regarded as a combination of the best features of modal truncation (efficiency) and internal balancing (accuracy); it is particularly well suited to the typical practical case of structures which possess clusters of close modes. Numerical results are then presented demonstrating the results obtained by applying subsystem balancing to the Air Force Phillips Laboratory ASTREX testbed, the Jet Propulsion Laboratory antenna facility, and the NASA Marshall Space Flight Center ACES structure. Author

**N93-18825*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AN APPLICATION OF THE OBSERVER/KALMAN FILTER IDENTIFICATION (OKID) TECHNIQUE TO HUBBLE FLIGHT DATA** **c89**
Jer-Nan Juang, Lucas G. Horta, W. Keith Belvin, John Sharkey (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.), and Frank H. Bauer (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 97-112 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

The objective of the current research is to identify vibration parameters, including frequencies, damping ratio and uncertainty characteristics, of the Hubble Space Telescope from flight data using an advanced system identification technique. The Observer/Kalman Filter Identification (OKID) technique is used to identify the vibration parameters. The OKID was recently developed by the researchers in the Spacecraft Dynamics Branch at NASA Langley Research Center. Author

**N93-18826*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**MICRO-PRECISION CONTROL/STRUCTURE INTERACTION TECHNOLOGY FOR LARGE OPTICAL SPACE SYSTEMS** **c74**
Samuel W. Sirlin and Robert A. Laskin *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 115-131 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

The CSI program at JPL is chartered to develop the structures and control technology needed for sub-micron level stabilization of future optical space systems. The extreme dimensional stability required for such systems derives from the need to maintain the alignment and figure of critical optical elements to a small fraction (typically 1/20th to 1/50th) of the wavelength of detected radiation. The wavelength is about 0.5 micron for visible light and 0.1 micron for ultra-violet light. This lambda/50 requirement is common to a broad class of optical systems including filled aperture telescopes (with monolithic or segmented primary mirrors), sparse aperture telescopes, and optical interferometers. The challenge for CSI arises when such systems become large, with spatially distributed optical elements mounted on a lightweight, flexible structure. In order to better understand the requirements for micro-precision CSI technology, a representative future optical system was identified and developed as an analytical testbed for CSI concepts and approaches. An optical interferometer was selected as a stressing example of the relevant mission class. The system that emerged was termed the Focus Mission Interferometer (FMI). This paper will describe the multi-layer control architecture used to address the FMI's nanometer level stabilization requirements. In addition the paper will discuss on-going and planned experimental work aimed at demonstrating that multi-layer CSI can work in practice in the relevant performance regime. Author

**N93-18827*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**STATIC AND DYNAMIC CHARACTERISTICS OF A PIEZOCERAMIC STRUT** **c39**
Brett J. Pokines (State Univ. of New York, Buffalo.), W. Keith Belvin, and Daniel J. Inman (State Univ. of New York, Buffalo.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1

Feb. 1993 p 133-140 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

The experimental study of a piezoceramic active truss is presented. This active strut is unique in that the piezoceramic configurations allow the stroke length of the strut not to be dependent on the piezoceramic material's expansion range but on the deflection range of the piezoceramic bender segment. A finite element model of a piezoceramic strut segment was constructed. Piezoceramic actuation was simulated using thermally induced strains. This model yielded information on the stiffness and force range of a bender element. The static and dynamic properties of the strut were identified experimentally. Feedback control was used to vary the stiffness of the strut. The experimentally verified model was used to explore implementation possibilities of the strut. Author

**N93-18828*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SYSTEM IDENTIFICATION AND STRUCTURAL CONTROL ON THE JPL PHASE B TESTBED**
Cheng-Chih Chu, John F. OBrien, and Boris J. Lurie *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 141-151 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

The primary objective of NASA's CSI program at JPL is to develop and demonstrate the CSI technology required to achieve high precision structural stability on large complex optical class spacecraft. The focus mission for this work is an orbiting interferometer telescope. Toward the realization of such a mission, a series of evolutionary testbed structures are being constructed. The JPL's CSI Phase B testbed is the second structure constructed in this series which is designed to study the pathlength control problem of the optical train of a stellar interferometer telescope mounted on a large flexible structure. A detailed description of this testbed can be found. This paper describes our efforts in the first phase of active structural control experiments of Phase B testbed using the active control approach where a single piezoelectric active member is used as an actuation device and the measurements include both colocated and noncolocated sensors. Our goal for this experiment is to demonstrate the feasibility of active structural control using both colocated and noncolocated measurements by means of successive control design and loop closing. More specifically, the colocated control loop was designed and closed first to provide good damping improvement over the frequency range of interest. The noncolocated controller was then designed with respect to a partially controlled structure to further improve the performance. Based on our approach, experimental closed-loop results have demonstrated significant performance improvement with excellent stability margins. Author

**N93-18829*#** Rome Lab., Griffiss AFB, NY.
**THE DEVELOPMENT AND TESTING OF THE LENS ANTENNA DEPLOYMENT DEMONSTRATION (LADD) TEST ARTICLE** **c32**
Mark L. Pugh, Robert J. Denton, Jr., and Timothy J. Strange (Phillips Lab., Edwards AFB, CA.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 153-160 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

The USAF Rome Laboratory and NASA Marshall Space Flight Center, through contract to Grumman Corporation, have developed a space-qualifiable test article for the Strategic Defense Initiative Organization to demonstrate the critical structural and mechanical elements of single-axis roll-out membrane deployment for Space Based Radar (SBR) applications. The Lens Antenna Deployment Demonstration (LADD) test article, originally designed as a shuttle-attached flight experiment, is a large precision space structure which is representative of operational designs for space-fed lens antennas. Although the flight experiment was cancelled due to funding constraints and major revisions in the Strategic Defense System (SDS) architecture, development of this test article was completed in June 1989. To take full advantage of the existence of this unique structure, a series of ground tests are proposed which include static, dynamic, and thermal measurements in a simulated space environment. An equally important objective of these tests is the verification of the analytical tools used to design and develop large precision space structures. Author

**N93-18830*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**INTEGRATED DESIGN OF THE CSI EVOLUTIONARY STRUCTURE: A VERIFICATION OF THE DESIGN METHODOLOGY**
Peiman G. Maghami, S. M. Joshi, Kenny B. Elliott, and J. E. Walz *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 161-179 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

One of the main objectives of the Controls-Structures Interaction (CSI) program is to develop and evaluate integrated controls-structures design methodology for flexible space structures. Thus far, integrated design methodologies for a class of flexible spacecraft, which require fine attitude pointing and vibration suppression with no payload articulation, have been extensively investigated. Various integrated design optimization approaches, such as single-objective optimization, and multi-objective optimization, have been implemented with an array of different objectives and constraints involving performance and cost measures such as total mass, actuator mass, steady-state pointing performance, transient performance, control power, and many more. These studies have been performed using an integrated design software tool (CSI-DESIGN CODE) which is under development by the CSI-ADM team at the NASA Langley Research Center. To date, all of these studies, irrespective of the type of integrated optimization posed or objectives and constraints used, have indicated that integrated controls-structures design results in an overall spacecraft design which is considerably superior to designs obtained through a conventional sequential approach. Consequently, it is believed that validation of some of these results through fabrication and testing of a structure which is designed through an integrated design approach is warranted. The objective of this paper is to present and discuss the efforts that have been taken thus far for the validation of the integrated design methodology. Author

**N93-18831*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**CONTROL/STRUCTURE INTERACTION DURING SPACE STATION FREEDOM-ORBITER BERTHING**
Tuyen Hua, E. Kubiak, Yeongching Lin (DYNACS Engineering Co., Inc., Houston, TX.), M. Kilby (DYNACS Engineering Co., Inc., Houston, TX.), and J. Mapar (DYNACS Engineering Co., Inc., Houston, TX.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 181-203 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

The berthing maneuver is essential for the construction and assembly of Space Station Freedom (SSF) and has a direct effect on the SSF assembly build up and SSF/Orbiter operations. The effects of flexible body dynamics coupled with the available control system may impose new requirements on the maneuver. The problem is further complicated by the effect of the SSF control system on the Shuttle Remote Manipulator System (SRMS). These effects will play a major role in the development of operational requirements which need to be identified and validated in order to assure total safety and maneuver execution during SSF construction. This paper presents the results of ongoing studies to investigate the Control/Structure Interaction (CSI) during the berthing operations. The problem is formulated in terms of multi-flex body equations of motion for SSF and the SRMS and on-orbit flight control systems for the SRMS and the SSF, which includes the Control Moment Gyro (CMG) and Reaction Control System (RCS) Attitude Control Systems (ACS). The SSF control system designs are based on the Preliminary Design Review (PDR) version of the Honeywell design. The simulation tool used for the analysis is briefly described and the CSI results are presented for given berthing scenarios. Author

**N93-18832*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**INTEGRATED MODELING OF ADVANCED OPTICAL SYSTEMS** **c74**
Hugh C. Briggs, Laura Needels, and B. Martin Levine *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 207-213 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

This poster session paper describes an integrated modeling and analysis capability being developed at JPL under funding provided by the JPL

Director's Discretionary Fund and the JPL Control/Structure Interaction Program (CSI). The posters briefly summarize the program capabilities and illustrate them with an example problem. The computer programs developed under this effort will provide an unprecedented capability for integrated modeling and design of high performance optical spacecraft. The engineering disciplines supported include structural dynamics, controls, optics and thermodynamics. Such tools are needed in order to evaluate the end-to-end system performance of spacecraft such as OSI, POINTS, and SMMM. This paper illustrates the proof-of-concept tools that have been developed to establish the technology requirements and demonstrate the new features of integrated modeling and design. The current program also includes implementation of a prototype tool based upon the CAESY environment being developed under the NASA Guidance and Control Research and Technology Computational Controls Program. This prototype will be available late in FY-92. The development plan proposes a major software production effort to fabricate, deliver, support and maintain a national-class tool from FY-93 through FY-95. Author

**N93-18833*#** Kentucky Univ., Lexington. Dept. of Engineering Mechanics.

**A COMPARISON OF REFINED MODELS FOR FLEXIBLE SUBASSEMBLIES**

Suzanne Weaver Smith and David C. Zimmerman (Florida Univ., Gainesville.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 215-230 Sponsored in part by Harris Corp. and Florida Space Grant Consortium (For primary document see N93-18818 06-18)
(Grant NAG1-1246)
Avail: CASI HC A03/MF A04

Interactions between structure response and control of large flexible space systems have challenged current modeling techniques and have prompted development of new techniques for model improvement. Due to the geometric complexity of envisioned large flexible space structures, finite element models (FEM's) will be used to predict the dynamic characteristics of structural components. It is widely accepted that these models must be experimentally 'validated' before their acceptance as the basis for final design analysis. However, predictions of modal properties (natural frequencies, mode shapes, and damping ratios) are often in error when compared to those obtained from Experimental Modal Analysis (EMA). Recent research efforts have resulted in the development of algorithmic approaches for model improvement, also referred to as system or structure identification. Author

**N93-18834*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**THE JPL PHASE B INTERFEROMETER TESTBED c74**

Daniel B. Eldred and Mike ONeal *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 231-237 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

Future NASA missions with large optical systems will require alignment stability at the nanometer level. However, design studies indicate that vibration resulting from on-board disturbances can cause jitter at levels three to four orders of magnitude greater than this. Feasibility studies have shown that a combination of three distinct control layers will be required for these missions, including disturbance isolation, active and passive structural vibration suppression, and active optical pathlength compensation. The CSI technology challenge is to develop these design and control approaches that can reduce vibrations in the optical train by a factor of 1000 to 10,000. The focus of the paper is on describing the Phase B Testbed structure and facility, as the experimental results are included in other papers presented at this same conference. Author

**N93-18835*#** Lockheed Missiles and Space Co., Sunnyvale, CA.

**DESIGN, ANALYSIS, AND TESTING OF HIGH FREQUENCY PASSIVELY DAMPED STRUTS c39**

Y. C. Yiu, L. Porter Davis, Kevin Napolitano, and R. Rory Ninneman *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 239-249 Prepared in cooperation with Honeywell, Inc., Phoenix, AZ; CSA Engineering, Inc., Palo Alto, CA; and Phillips Lab., Kirkland AFB, NM (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

Objectives of the research are: (1) to develop design requirements for damped struts to stabilize control system in the high frequency cross-over and spill-over range; (2) to design, fabricate and test viscously damped strut and viscoelastically damped strut; (3) to verify accuracy of design and analysis methodology of damped struts; and (4) to design and build test apparatus, and develop data reduction algorithm to measure strut complex stiffness. In order to meet the stringent performance requirements of the SPICE experiment, the active control system is used to suppress the dynamic responses of the low order structural modes. However, the control system also inadvertently drives some of the higher order modes unstable in the cross-over and spill-over frequency range. Passive damping is a reliable and effective way to provide damping to stabilize the control system. It also improves the robustness of the control system. Damping is designed into the SPICE testbed as an integral part of the control-structure technology. I.I.C.

**N93-18836*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**A COMPARISON OF VISCOELASTIC DAMPING MODELS c39**

Joseph C. Slater (Buffalo Univ., NY.), W. Keith Belvin, and Daniel J. Inman (Buffalo Univ., NY.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 251-262 (For primary document see N93-18818 06-18)
(Grant NGT-50541)
Avail: CASI HC A03/MF A04

Modern finite element methods (FEM's) enable the precise modeling of mass and stiffness properties in what were in the past overwhelmingly large and complex structures. These models allow the accurate determination of natural frequencies and mode shapes. However, adequate methods for modeling highly damped and high frequency dependent structures did not exist until recently. The most commonly used method, Modal Strain Energy, does not correctly predict complex mode shapes since it is based on the assumption that the mode shapes of a structure are real. Recently, many techniques have been developed which allow the modeling of frequency dependent damping properties of materials in a finite element compatible form. Two of these methods, the Golla-Hughes-McTavish method and the Lesieutre-Mingori method, model the frequency dependent effects by adding coordinates to the existing system thus maintaining the linearity of the model. The third model, proposed by Bagley and Torvik, is based on the Fractional Calculus method and requires fewer empirical parameters to model the frequency dependence at the expense of linearity of the governing equations. This work examines the Modal Strain Energy, Golla-Hughes-McTavish and Bagley and Torvik models and compares them to determine the plausibility of using them for modeling viscoelastic damping in large structures. Author

**N93-18837*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**STRUCTURAL CONTROL SENSORS FOR THE CASES GTF c39**

Hugh W. Davis (Ball Corp., Boulder, CO.) and Angelia P. Bukley *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 263-275 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

CASES (Controls, Astrophysics and Structures Experiment in Space) is a proposed space experiment to collect x-ray images of the galactic center and solar disk with unprecedented resolution. This requires precision pointing and suppression of vibrations in the long flexible structure that comprises the 32-m x-ray telescope optical bench. Two separate electro-optical sensor systems are provided for the ground test facility (GTF). The Boom Motion Tracker (BMT) measures eigenvector data for post-mission use in system identification. The Tip Displacement Sensor (TDS) measures boom tip position and is used as feedback for the closed-loop control system that stabilizes the boom. Both the BMT and the TDS have met acceptance specifications and were delivered to MSFC in February 1992. This paper describes the sensor concept, the sensor configuration as implemented in the GTF, and the results of characterization and performance testing.
Author

**N93-18838*#** Rockwell International Corp., Downey, CA. Space System Div.

**SSF LOADS AND CONTROLLABILITY DURING ASSEMBLY**

Charles R. Larson, S. Ghofranian, and E. Fujii *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 277-287 (For primary document see N93-18818 06-18)

Avail: CASI HC A03/MF A04

The Orbiter Primary Reaction Control System (PRCS) pulse width and firing frequency is restricted to prevent excessive loads in the Space Station Freedom (SSF). The feasibility of using the SSF Control Moment Gyros (CMG) as a secondary controller for load relief is evaluated. The studies revealed the CMG not only reduced loads but were useful for other SSF functions: vibration suppression and modal excitation. Vibration suppression lowers the g level for the SSF micro-g experiments and damps the low frequency oscillations that cause crew sickness. Modal excitation could be used for the modal identification experiment and health monitoring. The CMG's reduced the peak loads and damped the vibrations. They were found to be an effective multi-purpose ancillary device for SSF operation. Author

**N93-18839*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**EVALUATION OF INERTIAL DEVICES FOR THE CONTROL OF LARGE, FLEXIBLE, SPACE-BASED TELEROBOTIC ARMS c37**

Raymond C. Montgomery, Sean P. Kenny, Dave Ghosh (Lockheed Engineering and Sciences Co., Hampton, VA.), and Joram Shenhar (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 289-301 (For primary document see N93-18818 06-18)

Avail: CASI HC A03/MF A04

Inertial devices, including sensors and actuators, offer the potential of improving the tracking of telerobotic commands for space-based robots by smoothing payload motions and suppressing vibrations. In this paper, inertial actuators (specifically, torque-wheels and reaction-masses) are studied for that potential application. Batch simulation studies are presented which show that torque-wheels can reduce the overshoot in abrupt stop commands by 82 percent for a two-link arm. For man-in-the-loop evaluation, a real-time simulator has been developed which samples a hand-controller, solves the nonlinear equations of motion, and graphically displays the resulting motion on a computer workstation. Currently, two manipulator models, a two-link, rigid arm and a single-link, flexible arm, have been studied. Results are presented which show that, for a single-link arm, a reaction-mass/torque-wheel combination at the payload end can yield a settling time of 3 s for disturbances in the first flexible mode as opposed to 10 s using only a hub motor. A hardware apparatus, which consists of a single-link, highly flexible arm with a hub motor and a torque-wheel, has been assembled to evaluate the concept and is described herein. Author

**N93-18840*#** Florida Univ., Gainesville.

**A DARWINIAN APPROACH TO CONTROL-STRUCTURE DESIGN c63**

David C. Zimmerman *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 303-314 (For primary document see N93-18818 06-18)

(Grant NAG1-1017)

Avail: CASI HC A03/MF A04

Genetic algorithms (GA's), as introduced by Holland (1975), are one form of directed random search. The form of direction is based on Darwin's 'survival of the fittest' theories. GA's are radically different from the more traditional design optimization techniques. GA's work with a coding of the design variables, as opposed to working with the design variables directly. The search is conducted from a population of designs (i.e., from a large number of points in the design space), unlike the traditional algorithms which search from a single design point. The GA requires only objective function information, as opposed to gradient or other auxiliary information. Finally, the GA is based on probabilistic transition rules, as opposed to deterministic rules. These features allow the GA to attack problems with local-global minima, discontinuous design spaces and mixed variable problems, all in a single, consistent framework. Author

**N93-18841*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**CSI FLIGHT COMPUTER SYSTEM AND EXPERIMENTAL TEST RESULTS c60**

Dean W. Sparks, Jr., F. Peri, Jr., and P. Schuler *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 317-341 (For primary document see N93-18818 06-18)

Avail: CASI HC A03/MF A04

This paper describes the CSI Computer System (CCS) and the experimental tests performed to validate its functionality. This system is comprised of two major components: the space flight qualified Excitation and Damping Subsystem (EDS) which performs controls calculations; and the Remote Interface Unit (RIU) which is used for data acquisition, transmission, and filtering. The flight-like RIU is the interface between the EDS and the sensors and actuators positioned on the particular structure under control. The EDS and RIU communicate over the MIL-STD-1553B, a space flight qualified bus. To test the CCS under realistic conditions, it was connected to the Phase-0 CSI Evolutionary Model (CEM) at NASA Langley Research Center. The following schematic shows how the CCS is connected to the CEM. Various tests were performed which validated the ability of the system to perform control/structures experiments. Author

**N93-18842*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**OPTICAL PATHLENGTH CONTROL ON THE JPL PHASE B INTERFEROMETER TESTBED c35**

John T. Spanos and Zahidul H. Rahman *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 343-357 (For primary document see N93-18818 06-18)

Avail: CASI HC A03/MF A04

Design and implementation of a controller for optical pathlength compensation on a flexible structure is presented. Nanometer level pathlength control is demonstrated in the laboratory. The experimental results are in close agreement with performance predictions. Author

**N93-18843*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**DYNAMIC TEST RESULTS FOR THE CASES GROUND EXPERIMENT c14**

Angelia P. Bukley, Alan F. Patterson, and Victoria L. Jones (Logicon Control Dynamics Co., Huntsville, AL.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 359-366 (For primary document see N93-18818 06-18)

Avail: CASI HC A02/MF A04

The Controls, Astrophysics, and Structures Experiment in Space (CASES) Ground Test Facility (GTF) has been developed at Marshall Space Flight Center (MSFC) to provide a facility for the investigation of Controls/Structures Interaction (CSI) phenomena, to support ground testing of a potential shuttle-based CASES flight experiment, and to perform limited boom deployment and retraction dynamics studies. The primary objectives of the ground experiment are to investigate CSI on a test article representative of a Large Space Structure (LSS); provide a platform for Guest Investigators (GI's) to conduct CSI studies; to test and evaluate LSS control methodologies, system identification (ID) techniques, failure mode analysis; and to compare ground test predictions and flight results. The proposed CASES flight experiment consists of a 32 meter deployable/retractable boom at the end of which is an occulting plate. The control objective of the experiment is to maintain alignment of the tip plate (occulter) with a detector located at the base of the boom in the orbiter bay. The tip plate is pointed towards a star, the sun, or the galactic center to collect high-energy X-rays emitted by these sources. The tip plate, boom, and detector comprise a Fourier telescope. The occulting holes in the tip plate are approximately one millimeter in diameter making the alignment requirements quite stringent. Control authority is provided by bidirectional linear thrusters located at the boom tip and Angular Momentum Exchange Devices (AMED's) located at mid-boom and at the tip. The experiment embodies a number of CSI control problems including vibration suppression, pointing a long flexible structure, and disturbance rejection. The CASES GTF is representative of the proposed flight experiment with identical control objectives. Author

**N93-18844*#** Phillips Lab., Edwards AFB, CA.
**RESULTS OF THE ADVANCED SPACE STRUCTURES TECHNOLOGY RESEARCH EXPERIMENTS (ASTREX) HARDWARE AND CONTROL DEVELOPMENT**
Derek F. Cossey *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 367-372 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

Future DOD, NASA, and SDI space systems will be larger than any spacecraft flown before. The economics of placing these Precision Space Systems (PSS) into orbit dictates that they be as low in mass as possible. This stringent weight reduction creates structural flexibility causing severe technical problems when combined with the precise shape and pointing requirements associated with many future PSS missions. Development of new Control Structure Interaction (CSI) technologies which can solve these problems and enable future space missions is being conducted at the Phillips Laboratory, On-Location Site, CA. Author

**N93-18845*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DESIGN OPTIMIZATION OF THE JPL PHASE B TESTBED**
Mark H. Milman, M. Salama, M. Wette, and Cheng-Chih Chu *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 373-391 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

Increasingly complex spacecraft will benefit from integrated design and optimization of structural, optical, and control subsystems. Integrated design optimization will allow designers to make tradeoffs in objectives and constraints across these subsystems. The location, number, and types of passive and active devices distributed along the structure can have a dramatic impact on overall system performance. In addition, the manner in which structural mass is distributed can also serve as an effective mechanism for attenuating disturbance transmission between source and sensitive system components. This paper presents recent experience using optimization tools that have been developed for addressing some of these issues on a challenging testbed design problem. This particular testbed is one of a series of testbeds at the Jet Propulsion Laboratory under the sponsorship of the NASA Control Structure Interaction (CSI) Program to demonstrate nanometer level optical pathlength control on a flexible truss structure that emulates a spaceborne interferometer. Author

**N93-18846*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**PIEZOELECTRIC DEVICES FOR VIBRATION SUPPRESSION: MODELING AND APPLICATION TO A TRUSS STRUCTURE**
Chin C. Won (Lockheed Engineering and Sciences Co., Hampton, VA.), Dean W. Sparks, Jr., W. Keith Belvin, and Jeff L. Sulla (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 393-412 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

For a space structure assembled from truss members, an effective way to control the structure may be to replace the regular truss elements by active members. The active members play the role of load carrying elements as well as actuators. A piezo strut, made of a stack of piezoceramics, may be an ideal active member to be integrated into a truss space structure. An electrically driven piezo strut generates a pair of forces, and is considered as a two-point actuator in contrast to a one-point actuator such as a thruster or a shaker. To achieve good structural vibration control, sensing signals compatible to the control actuators are desirable. A strain gage or a piezo film with proper signal conditioning to measure member strain or strain rate, respectively, are ideal control sensors for use with a piezo actuator. The Phase 0 CSI Evolutionary Model (CEM) at NASA Langley Research Center used cold air thrusters as actuators to control both rigid body motions and flexible body vibrations. For the Phase 1 and 2 CEM, it is proposed to use piezo struts to control the flexible modes and thrusters to control the rigid body modes. A tenbay truss structure with active piezo struts is built to study the modeling, controller designs, and experimental issues. In this paper, the tenbay structure with piezo active members is modelled using an energy method approach. Decentralized and centralized control schemes are designed and implemented, and preliminary analytical and experimental results are presented. Author

**N93-18852*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**SPACECRAFT DYNAMICS CHARACTERIZATION AND CONTROL SYSTEM FAILURE DETECTION Semiannual Status Report, 9 Feb. - 8 Aug. 1990**
Wallace E. VanderVelde 24 Aug. 1990 12 p
(Grant NAG1-968)
(NASA-CR-192190; NAS 1.26:192190) Avail: CASI HC A03/MF A01

Two important aspects of the control of large space structures are studied: the modeling of deployed or erected structures including nonlinear joint characteristics; and the detection and isolation of failures of the components of control systems for large space structures. The emphasis in the first task is on efficient representation of the dynamics of large and complex structures having a great many joints. The initial emphasis in the second task is on experimental evaluation of FDI methodologies using ground-based facilities in place at NASA Langley Research Center and Marshall Space Flight Center. The progress to date on both research tasks is summarized. Author

**N93-18853*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**CONTROLS-STRUCTURES INTERACTION GUEST INVESTIGATOR PROGRAM: OVERVIEW AND PHASE 1 EXPERIMENTAL RESULTS AND FUTURE PLANS**
Rudeen Smith-Taylor and Sharon E. Tanner Washington Feb. 1993 49 p Presented at the American Astronautical Society Guidance and Control Conference, Keystone, CO, 2-6 Feb. 1991 Previously announced in IAA as A93-15590
(RTOP 590-14-91-01)
(NASA-TM-4412; L-17052; NAS 1.15:4412) Avail: CASI HC A03/MF A01

The NASA Controls-Structures Interaction (CSI) Guest Investigator program is described in terms of its support of the development of CSI technologies. The program is based on the introduction of CSI researchers from industry and academia to available test facilities for experimental validation of technologies and methods. Phase 1 experimental results are reviewed with attention given to their use of the Mini-MAST test facility and the facility for the Advance Control Evaluation of Structures. Experiments were conducted regarding the following topics: collocated/noncollocated controllers, nonlinear math modeling, controller design, passive/active suspension systems design, and system identification and fault isolation. The results demonstrate that significantly enhanced performance from the control techniques can be achieved by integrating knowledge of the structural dynamics under consideration into the approaches. Author

**N93-18859*#** Science Applications International Corp., Huntsville, AL.
**OPTIMIZATION TECHNIQUES APPLIED TO PASSIVE MEASURES FOR IN-ORBIT SPACECRAFT SURVIVABILITY Final Report**
Robert A. Mog, Michael J. Helba, and Janeil B. Hill Jun. 1992 122 p
(Contract NAS8-37378)
(NASA-CR-184486; NAS 1.26:184486) Avail: CASI HC A06/MF A02

The purpose of this research is to provide Space Station Freedom protective structures design insight through the coupling of design/material requirements, hypervelocity impact phenomenology, meteoroid and space debris environment sensitivities, optimization techniques and operations research strategies, and mission scenarios. The goals of the research are: (1) to develop a Monte Carlo simulation tool which will provide top level insight for Space Station protective structures designers; (2) to develop advanced shielding concepts relevant to Space Station Freedom using unique multiple bumper approaches; and (3) to investigate projectile shape effects on protective structures design. Author

**N93-18928*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**THE FIFTH NASA/DOD CONTROLS-STRUCTURES INTERACTION TECHNOLOGY CONFERENCE, PART 2**
Jerry R. Newsom, comp. Washington Feb. 1993 378 p Conference held in Lake Tahoe, NV, 3-5 Mar. 1992

(RTOP 590-14-41-01)
(NASA-CP-3177-Pt-2; L-17174-Pt-2; NAS 1.55:3177-Pt-2) Avail: CASI HC A17/MF A03

This publication is a compilation of the papers presented at the Fifth NASA/DoD Controls-Structures Interaction (CSI) Technology Conference held in Lake Tahoe, Nevada, March 3-5, 1992. The conference, which was jointly sponsored by the NASA Office of Aeronautics and Space Technology and the Department of Defense, was organized by the NASA Langley Research Center. The purpose of this conference was to report to industry, academia, and government agencies on the current status of controls-structures interaction technology. The agenda covered ground testing, integrated design, analysis, flight experiments and concepts. For individual titles, see N93-18929 through N93-18944.

**N93-18929*#** Martin Marietta Corp., Denver, CO. Robotics and Advanced Controls Section.

**CSI RELATED DYNAMICS AND CONTROL ISSUES IN SPACE ROBOTICS** **c37**

Eric Schmitz and Madison Ramey *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 415-433 (For primary document see N93-18928 06-18)
Avail: CASI HC A03/MF A03

The research addressed includes: (1) CSI issues in space robotics; (2) control of elastic payloads, which includes 1-DOF example, and 3-DOF harmonic drive arm with elastic beam; and (3) control of large space arms with elastic links, which includes testbed description, modeling, and experimental implementation of colocated PD and end-point tip position controllers. I.I.C.

**N93-18930*#** Ohio State Univ., Columbus. Dept. of Aeronautical and Astronautical Engineering.

**OPTIMIZATION FOR EFFICIENT STRUCTURE-CONTROL SYSTEMS**

Hayrani Oz and Narendra S. Khot (Wright Lab., Wright-Patterson AFB, OH.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 435-454 (For primary document see N93-18928 06-18)
Avail: CASI HC A03/MF A03

The efficiency of a structure-control system is a nondimensional parameter which indicates the fraction of the total control power expended usefully in controlling a finite-dimensional system. The balance of control power is wasted on the truncated dynamics serving no useful purpose towards the control objectives. Recently, it has been demonstrated that the concept of efficiency can be used to address a number of control issues encountered in the control of dynamic systems such as the spillover effects, selection of a good input configuration and obtaining reduced order control models. Reference (1) introduced the concept and presented analyses of several Linear Quadratic Regulator designs on the basis of their efficiencies. Encouraged by the results of Ref. (1), Ref. (2) introduces an efficiency modal analysis of a structure-control system which gives an internal characterization of the controller design and establishes the link between the control design and the initial disturbances to affect efficient structure-control system designs. The efficiency modal analysis leads to identification of principal controller directions (or controller modes) distinct from the structural natural modes. Thus ultimately, many issues of the structure-control system revolve around the idea of insuring compatibility of the structural modes and the controller modes with each other, the better the match the higher the efficiency. A key feature in controlling a reduced order model of a high dimensional (or infinity-dimensional distributed parameter system) structural dynamic system must be to achieve high efficiency of the control system while satisfying the control objectives and/or constraints. Formally, this can be achieved by designing the control system and structural parameters simultaneously within an optimization framework. The subject of this paper is to present such a design procedure. Author

**N93-18931*#** Ball Aerospace Systems Div., Boulder, CO. Electro-Optics and Cryogenics Div.

**C-SIDE: THE CONTROL-STRUCTURE INTERACTION DEMONSTRATION EXPERIMENT**

James B. Mohl and Hugh W. Davis *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 455-474 (For primary document see N93-18928 06-18)
Avail: CASI HC A03/MF A03

The Control-Structure Interaction Demonstration Experiment (C-SIDE) is sponsored by the Electro-Optics and Cryogenics Division of Ball Aerospace Systems Group. Our objective is to demonstrate methods of solution to structure control problems utilizing currently available hardware in a system that is an extension of our corporate experience. The larger space structures with which Ball has been associated are the SEASAT radar antenna, Shuttle Imaging Radar (SIR) -A, -B and -C antennas and the Radarsat spacecraft. The motivation for the C-SIDE configuration is to show that integration of active figure control in the radar's system-level design can relieve antenna mechanical design constraints. This presentation is primarily an introduction to the C-SIDE testbed. Its physical and functional layouts, and major components are described. The sensor is of special interest as it enables direct surface figure measurements from a remote location. The Remote Attitude Measurement System (RAMS) makes high-rate, unobtrusive measurements of many locations, several of which may be collocated easily with actuators. The control processor is a 386/25 executing a reduced order model-based algorithm with provision for residual mode filters to compensate for structure interaction. The actuators for the ground demonstration are non-contacting, linear force devices. Results presented illustrate some basic characteristics of control-structure interaction with this hardware. The testbed will be used for evaluation of current technologies and for research in several areas. A brief indication of the evolution of the C-SIDE is given at the conclusion. Author

**N93-18932*#** California Univ., Los Angeles. Dept. of Electrical Engineering.

**AN EXPLICIT SOLUTION TO THE OPTIMAL LQG PROBLEM FOR FLEXIBLE STRUCTURES WITH COLLOCATED RATE SENSORS**

A. V. Balakrishnan *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 475-488 (For primary document see N93-18928 06-18)
(Contract NAS1-19158)
Avail: CASI HC A03/MF A03

We present a class of compensators in explicit form (not requiring numerical computer calculations) for stabilizing flexible structures with collocated rate sensors. They are based on the explicit solution, valid for both Continuum and FEM Models, of the LQG problem for minimizing mean square rate. They are robust with respect to system stability (will not destabilize modes even with mismatch of parameters), can be instrumented in state space form suitable for digital controllers, and can be specified directly from the structure modes and mode 'signature' (displacement vectors at sensor locations). Some simulation results are presented for the NASA LaRC Phase-Zero Evolutionary Model - a modal Trust model with 86 modes - showing damping ratios attainable as a function of compensator design parameters and complexity. Author

**N93-18933*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**A SYNOPSIS OF TEST RESULTS AND KNOWLEDGE GAINED FROM THE PHASE-0 CSI EVOLUTIONARY MODEL**

W. Keith Belvin, Kenny B. Elliott, and Lucas G. Horta *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 489-508 (For primary document see N93-18928 06-18)
Avail: CASI HC A03/MF A03

The Phase-0 CSI Evolutionary Model (CEM) is a testbed for the study of space platform global line-of-sight (LOS) pointing. Now that the tests have been completed, a summary of hardware and closed-loop test experiences is necessary to insure a timely dissemination of the knowledge gained. The testbed is described and modeling experiences are presented followed by a summary of the research performed by various investigators. Some early lessons on implementing the closed-loop controllers are described with particular emphasis on real-time computing requirements. A summary of closed-loop studies and a synopsis of test results are presented. Plans for evolving the CEM from phase 0 to phases 1 and 2 are also described. Subsequently, a summary of knowledge gained from the design and testing of the Phase-0 CEM is made. Author

**N93-18934*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**CONTROLS-STRUCTURES-INTERACTION DYNAMICS DURING RCS CONTROL OF THE ORBITER/SRMS/SSF CONFIGURATION**

J. A. Schliesing and L. S. Shieh (Houston Univ., TX.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 509-527 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

During the assembly flights of the Space Station Freedom (SSF), the Orbiter will either dock with the SSF and retract to the final berthed position, or will grapple the SSF using the Shuttle Remote Manipulator System (SRMS) and maneuver the SRMS coupled vehicles to their final berthed position. The SRMS method is expected to take approximately one to one and a half hours to complete and require periodic attitude corrections by either the Orbiter or the SSF reaction control system (RCS) or continuous control by a control moment gyro (CMG) system with RCS desaturation as required. Free drift of the attached vehicles is not currently thought to be acceptable because the desired system attitude will quickly deteriorate due to unbalanced gravity gradient and aerodynamic torques resulting in power generation problems, thermodynamic control problems, and communications problems. This paper deals with the simulation and control of the SRMS during trunnion/latch interaction dynamics and during RCS maneuvers. The SRMS servo drive joints have highly non-linear elastic characteristics which tend to degrade sensitive control strategies. In addition the system natural frequencies are extremely low and depend on the drive joint deflections and SRMS geometric position. The lowest mean period of oscillation for the Orbiter/SRMS/SSF(M86) system in brakes hold mode positioned near the final berthed position is approximately 120 seconds. A detailed finite element model of the SRMS has been developed and used in a newly developed SRMS systems dynamics simulation to investigate the non-linear transient response dynamics of the Orbiter/SRMS/SSF systems. The present SRMS control strategy of brakes only recommended by the Charles Draper Labs is contrasted with a robust controller developed by the authors. The robust controller uses an optimal inear quadratic regulator (LQR) to optimally place the closed-loop poles of a multivariable continuous-time system within the common region of an open sector with the sector angle plus or minus 45 degrees from the negative real axis, and the left-hand side of a parallel to the imaginary axis in the complex s-plane. This guarantees that the critical damping ratio for the desired control modes is equal to or in excess of 0.707. The matrix sign function is used for solving the Riccati equations which appear in the controller design procedure. Fast and stable algorithms have recently been developed for the computation of the matrix sign function. Simulation results are given which demonstrate the potential CSI involvement for the current SRMS control system and the proposed control system. Author

**N93-18935*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**MODEL REDUCTION IN INTEGRATED CONTROLS-STRUCTURES DESIGN**

Peiman G. Maghami *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 529-549 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

It is the objective of this paper to present a model reduction technique developed for the integrated controls-structures design of flexible structures. Integrated controls-structures design problems are typically posed as nonlinear mathematical programming problems, where the design variables consist of both structural and control parameters. In the solution process, both structural and control design variables are constantly changing; therefore, the dynamic characteristics of the structure are also changing. This presents a problem in obtaining a reduced-order model for active control design and analysis which will be valid for all design points within the design space. In other words, the frequency and number of the significant modes of the structure (modes that should be included) may vary considerably throughout the design process. This is also true as the locations and/or masses of the sensors and actuators change. Moreover, since the number of design evaluations in the integrated design process could easily run into thousands, any feasible order-reduction method should not require model reduction analysis at every design iteration. In this paper a novel and efficient technique for model reduction in the integrated controls-structures design process, which addresses these issues, is presented. Author

**N93-18936*#** Massachusetts Inst. of Tech., Cambridge. Space Engineering Research Center.

**THE MIDDECK ACTIVE CONTROL EXPERIMENT (MACE)** **c16**

David W. Miller, Raymond B. Sepe, Daniel Rey, Erik Saarmaa, and Edward F. Crawley *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 551-565 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

The Middeck Active Control Experiment (MACE) is a NASA In-Step and Control Structure Interaction (CSI) Office funded Shuttle middeck experiment. The objective is to investigate the extent to which closed-loop behavior of flexible spacecraft in zero-gravity (0-g) can be predicted. This prediction becomes particularly difficult when dynamic behavior during ground testing exhibits extensive suspension and direct gravity coupling. On-orbit system identification and control reconfiguration is investigated to improve performance which would otherwise be limited due to errors in prediction. The program is presently in its preliminary design phase with launch expected in the summer of 1994. The MACE test article consists of three attitude control torque wheels, a two axis gimballing payload, inertial sensors and a flexible support structure. With the acquisition of a second payload, this will represent a multiple payload platform with significant structural flexibility. This paper presents on-going work in the areas of modelling and control of the MACE test article in the zero and one-gravity environments. Finite element models, which include suspension and gravity effects, and measurement models, derived from experimental data, are used as the basis for Linear Quadratic Gaussian controller designs. Finite element based controllers are analytically used to study the differences in closed-loop performance as the test article transitions between the 0-g and 1-g environments. Measurement based controllers are experimentally applied to the MACE test article in the 1-g environment and achieve over an order of magnitude improvement in payload pointing accuracy when disturbed by a broadband torque disturbance. The various aspects of the flight portion of the experiment are also discussed. Author

**N93-18937*#** General Electric Co., Philadelphia, PA. Astro Space Div.

**CSI/MMC STUDIES FOR IMPROVING JITTER PERFORMANCE FOR LARGE MULTI-PAYLOAD PLATFORMS Final Report**

John Chionchio and Michael Garnek *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 569-615 (For primary document see N93-18928 06-18)

(Contract NAS5-32500)

Avail: CASI HC A03/MF A03

This report includes: (1) introduction to mirror motion compensation (MMS); (2) EOS platform model and disturbance definition; (3) instrument jitter response; (4) modeling uncertainties, which includes frequency, damping, lag filter, and mirror inertia; (5) multiple disturbances; (6) feedback; and (7) summary. I.I.C.

**N93-18938*#** TRW Space Technology Labs., Redondo Beach, CA.

**PRECISION SLEW/SETTLE TECHNOLOGIES FOR FLEXIBLE SPACECRAFT**

R. A. Manning and Victor A. Spector *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 617-637 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

Many spacecraft missions in the next decade will require both a high degree of agility and precision pointing. Agility includes both rotational maneuvering for retargeting and translational motion for orbit adjustment and threat avoidance. The major challenge associated with such missions is the need for control over a wide range of amplitudes and frequencies, ranging from tens of degrees at less than 1 Hz to a few micron radians at hundreds of Hz. TRW's internally funded Precision Control of Agile Spacecraft (PCAS) project is concerned with developing and validating in hardware the tools necessary to successfully complete the combined agile maneuvering/precision pointing missions. Development has been undertaken on a number of fronts for quietly slewing flexible structures. Various methods

for designing slew torque profiles have been investigated. Prime candidates for slew/settle scenarios include Inverse Dynamics and Parameterized Function Space. Joint work with Processor Bayo at the University of California, Santa Barbara and Professor Flashner at the University of Southern California has led to promising torque profile design methods. Active and passive vibration suppression techniques also play a key role for rapid slew/settle mission scenarios. Active members with local control loops and passive members with high loss factor viscoelastic material have been selected for hardware verification. Progress in each of these areas produces large gains in the quiet slewing of flexible spacecraft. The main thrust of the effort to date has been the development of a modular testbed for hardware validation of the precision control concepts. The testbed is a slewing eighteen foot long flexible truss. Active and passive members can be interchanged with the baseline aluminum members to augment the inherent damping in the system. For precision control the active members utilize control laws running on a high speed digital structural control processor. Tip and midspan motions of the truss are determined using optical sensors while accelerometers can be used to monitor the motions of other points of interest. Preliminary results indicate that a mix of technologies produces the greatest benefit. For example, shaping the torque profile produces large improvements in slew/settle performance, but without added damping settling times may still be excessive. With the introduction of moderate amounts of damping, slew/settle performance is vastly improved. On the other hand, introducing damping without shaping the torque profile may not yield the desired level of performance. Author

**N93-18939*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

**AVERAGE-COST BASED ROBUST STRUCTURAL CONTROL**

Nesbitt W. Hagood *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 639-664 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

A method is presented for the synthesis of robust controllers for linear time invariant structural systems with parameterized uncertainty. The method involves minimizing quantities related to the quadratic cost (H2-norm) averaged over a set of systems described by real parameters such as natural frequencies and modal residues. Bounded average cost is shown to imply stability over the set of systems. Approximations for the exact average are derived and proposed as cost functionals. The properties of these approximate average cost functionals are established. The exact average and approximate average cost functionals are used to derive dynamic controllers which can provide stability robustness. The robustness properties of these controllers are demonstrated in illustrative numerical examples and tested in a simple SISO experiment on the MIT multi-point alignment testbed. Author

**N93-18940*#** Lockheed Missiles and Space Co., Palo Alto, CA. Research Lab.

**MODAL CHARACTERIZATION OF THE ASCIE SEGMENTED OPTICS TESTBED: NEW ALGORITHMS AND EXPERIMENTAL RESULTS c74**

Alain C. Carrier and Jean-Noel Aubrun *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 665-705 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

New frequency response measurement procedures, on-line modal tuning techniques, and off-line modal identification algorithms are developed and applied to the modal identification of the Advanced Structures/Controls Integrated Experiment (ASCIE), a generic segmented optics telescope test-bed representative of future complex space structures. The frequency response measurement procedure uses all the actuators simultaneously to excite the structure and all the sensors to measure the structural response so that all the transfer functions are measured simultaneously. Structural responses to sinusoidal excitations are measured and analyzed to calculate spectral responses. The spectral responses in turn are analyzed as the spectral data become available and, which is new, the results are used to maintain high quality measurements. Data acquisition, processing, and checking procedures are fully automated. As the acquisition of the frequency response progresses, an on-line algorithm keeps track of the actuator force distribution that maximizes the structural response to automatically tune to a structural mode when approaching a resonant frequency. This tuning is insensitive to delays, ill-conditioning, and nonproportional damping. Experimental results show that is useful for modal surveys even in high modal density regions. For thorough modeling, a constructive procedure is proposed to identify the dynamics of a complex system from its frequency response with the minimization of a least-squares cost function as a desirable objective. This procedure relies on off-line modal separation algorithms to extract modal information and on least-squares parameter subset optimization to combine the modal results and globally fit the modal parameters to the measured data. The modal separation algorithms resolved modal density of 5 modes/Hz in the ASCIE experiment. They promise to be useful in many challenging applications. Author

**N93-18941*#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Wesseling (Germany).

**ACTIVE SUSPENSION DESIGN FOR A LARGE SPACE STRUCTURE GROUND TEST FACILITY**

Thomas J. H. Lange and Clemens Schlegel *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 707-725 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

The expected future high performance requirements for Large Space Structures (LSS) enforce technology innovations such as active vibration damping techniques e.g., by means of structure sensors and actuators. The implementation of new technologies like that requires an interactive and integrated structural and control design with an increased effort in hardware validation by ground testing. During the technology development phase generic system tests will be most important covering verification and validation aspects up to the preparation and definition of relevant space experiments. For many applications using advanced designs it is deemed necessary to improve existing testing technology by further reducing disturbances and gravity coupling effects while maintaining high performance reliability. A key issue in this context is the improvement of suspension techniques. The ideal ground test facility satisfying these requirements completely will never be found. The highest degree of reliability will always be obtained by passive suspension methods taking into account severe performance limitations such as non-zero rigid body modes, restriction of degrees of freedom of motion and frequency response limitations. Passive compensation mechanisms, e.g., zero-spring-rate mechanisms, either require large moving masses or they are limited with respect to low-frequency performance by friction, stiction or other non-linear effects. With active suspensions these limitations can be removed to a large extent thereby increasing the range of applications. Despite an additional complexity which is associated with a potential risk in reliability their development is considered promising due to the amazing improvement of real-time control technology which is still continuing. Author

**N93-18942*#** DYNACS Engineering Co., Inc., Palm Harbor, FL.

**MODELING, SYSTEM IDENTIFICATION, AND CONTROL OF ASTREX**

Nandu S. Abhyankar, J. Ramakrishnan, K. W. Byun, A. Das (Phillips Lab., Edwards AFB, CA.), Derek F. Cossey (Phillips Lab., Edwards AFB, CA.), and J. Berg (Phillips Lab., Edwards AFB, CA.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 727-749 (For primary document see N93-18928 06-18)

Avail: CASI HC A03/MF A03

The modeling, system identification and controller design aspects of the ASTREX precision space structure are presented in this work. Modeling of ASTREX is performed using NASTRAN, TREETOPS and I-DEAS. The models generated range from simple linear time-invariant models to nonlinear models used for large angle simulations. Identification in both the time and frequency domains are presented. The experimental set up and the results from the identification experiments are included. Finally, controller design for ASTREX is presented. Simulation results using this optimal controller demonstrate the controller performance. Finally the future directions and plans for the facility are addressed. Author

**N93-18943*#** Cincinnati Univ., OH. Dept. of Aerospace Engineering.

**ANALYSIS, DESIGN, AND TESTING OF A LOW COST, DIRECT FORCE COMMAND LINEAR PROOF MASS ACTUATOR FOR STRUCTURAL CONTROL**

G. L. Slater, Stuart Shelley, and Mark Jacobson (Ohio State Univ.,

Columbus.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 751-761 (For primary document see N93-18928 06-18)
Avail: CASI HC A03/MF A03

In this paper, the design, analysis, and test of a low cost, linear proof mass actuator for vibration control is presented. The actuator is based on a linear induction coil from a large computer disk drive. Such disk drives are readily available and provide the linear actuator, current feedback amplifier, and power supply for a highly effective, yet inexpensive, experimental laboratory actuator. The device is implemented as a force command input system, and the performance is virtually the same as other, more sophisticated, linear proof mass systems. Author

**N93-18944*#** Naval Research Lab., Washington, DC.
**CSI FLIGHT EXPERIMENT PROJECTS OF THE NAVAL RESEARCH LABORATORY**
Shalom Fisher *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 763-778 (For primary document see N93-18928 06-18)
Avail: CASI HC A03/MF A03

The Naval Research Laboratory (NRL) is involved in an active program of CSI flight experiments. The first CSI flight experiment of the Naval Research Laboratory, the Low Power Atmospheric Compensation Experiment (LACE) dynamics experiment, has successfully measured vibrations of an orbiting satellite with a ground-based laser radar. The observations, made on January 7, 8 and 10, 1991, represent the first ever measurements of this type. In the tests, a narrowband heterodyne CO2 laser radar, operating at a wavelength of 10.6 microns, detected vibration induced differential-Doppler signatures of the LACE satellite. Power spectral densities of forced oscillations and modal frequencies and damping rates of free-damped vibrations were obtained and compared with finite element structural models of the LACE system. Another manifested flight experiment is the Advanced Controls Technology Experiment (ACTEX) designed to demonstrate active and passive damping with piezo-electric (PZT) sensors and actuators. This experiment was developed under the management of the Air Force Phillips Laboratory with integration of the experiment at NRL. It is to ride as a secondary, or 'piggyback,' experiment on a future Navy satellite. Author

**N93-18955#** Colorado Univ., Boulder. Dept. of Telecommunications.
**MOBILE SATELLITE SERVICES: A SURVEY OF BUSINESS NEEDS M.S. Thesis**
Eric M. Hainzer 1992 110 p
(AD-A259031) Avail: CASI HC A06/MF A02

Conceptualizing and understanding the international business traveler's communication requirements by the use of a survey and selection of a mobile satellite system that satisfies those requirements are discussed. Chapter 5 incorporates an in depth analysis of the respondent's answers to survey questions and graphing them with frequency distribution histograms. Chapter 6 concludes with a selection of the most likely MSS manufacturer who appears to satisfy those communication requirements discovered in the previous chapter. Following a general-introduction in Chapter 1, the current climate of mobile satellite system (MSS) providers is discussed in Chapter 2. Chapter 3 assesses the implication of launch vehicles as it pertains to the political, technical, and financial aspects of MSS manufacturers and users. Special attention is provided, when possible, between the political environment and its relationship with forefront technology. In chapter 4, the procedure that was used to create the survey and its research methodology is shown. Graphs and charts are used, where appropriate, for the purpose of clarity and readability. GRA

**N93-19068#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A SYNTHETIC ENVIRONMENT FOR SATELLITE MODELING AND SATELLITE ORBITAL MOTION M.S. Thesis**
David L. Pond Dec. 1992 54 p
(AD-A258847; AFIT/GCS/ENG/92D-12) Avail: CASI HC A04/MF A01

Analysts tasked to study satellites moving in space must often rely on photographs to conduct their analysis. Often these photographs do not adequately represent how satellites move in space, their spatial relationships, or their interaction with other satellites. What analysts need is a three-dimensional synthetic environment that depicts satellites as they actually move and interact in space. The early development of the Satellite Modeler (SM), a system that allows analysts to study satellite motion and maneuvering of computer aided design (CAD) models of those satellites in a three-dimensional orbit, is addressed. The system contains equipment that allows analysts to view the models either in a head mounted display, on a high resolution monitor, or on a computer workstation monitor. Analysts can also video tape a session in the synthetic environment. A voice recognition system allows the analyst to give voice commands to the synthetic environment that modify model movement or his view of the models. The modeler also allows the analyst to script the movements of models to duplicate the movements of actual satellites in space. GRA

**N93-19339#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**VIBRATION SUPPRESSION IN LARGE FLEXIBLE SPACE STRUCTURES USING ACTIVE CONTROL TECHNIQUES M.S. Thesis**
Chad T. Matheson Dec. 1992 195 p
(AD-A258916; AFIT/GAE/ENY/92D-13) Avail: CASI HC A09/MF A03

This report investigates the use of active vibration control techniques applied to the PACOSS Dynamic Test Article as an experimental structure. In the course of the research, a mathematical model of the lightly damped experimental structure was created based on experimental data. This model was used in the design of two classes of controllers. The first class is pure rate feedback of the structure's measured states such that global stability is insured. The second type of controller investigated was an optimal controller (LQG) that was created using the truncated mathematical model. The rate feedback controller showed significant improvements in the damping of the structures flexible modes. The optimal controller proved to be stable only for negligible gains and did not improve structural damping significantly. GRA

**N93-19350#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN APPROXIMATE SOLUTION FOR THE LINEARIZED SPINUP DYNAMICS OF A DUAL-SPIN SPACECRAFT M.S. Thesis**
David L. Kinney Dec. 1992 82 p
(AD-A258903; AFIT/GA/ENY/92D-11) Avail: CASI HC A05/MF A01

An approximate solution is obtained for the linearized equations of motion for the spinup dynamics of a dual-spin spacecraft. The approximation is obtained from the WKB (Wentzel, Kramers, and Brillouin) method, which usually generates a divergent series. Comparison between the WKB solution and the numerically integrated solution are used to study the effects of spinup torque magnitude and the number of WKB terms used on the accuracy of the approximation. The WKB method generates accurate approximations for small spinup torques using as few as two terms in the series when no singularities are present in the WKB terms during the spinup time interval. For an axisymmetric spacecraft, the WKB series truncates after one term and provides the exact solution to the equations of motion. GRA

**N93-19366#** General Dynamics Corp., San Diego, CA.
**ATLAS MISSION PLANNER'S GUIDE**
Apr. 1992 222 p Revised
(AD-A258845) Avail: CASI HC A10/MF A03

The Atlas Mission Planner's Guide presents new information on the performance capabilities of Atlas. Higher performance is now offered as a result of a successful development program and an ongoing enhancement program. A greater range of vehicle configurations and performance levels is also offered to allow a closer match to customer requirements and to lower cost. The performance data is presented in sufficient detail for preliminary assessment of the General Dynamics vehicle family for missions. The guide includes essential technical and programmatic data for preliminary mission planning and preliminary spacecraft design. A brief description of the Atlas vehicles and the launch facilities is also given. Author

**N93-19890*#** Clarkson Univ., Potsdam, NY. Dept. of Electrical and Computer Engineering.
**ANALYSIS OF ELECTROMAGNETIC INTERFERENCE FROM POWER SYSTEM PROCESSING AND TRANSMISSION COMPONENTS FOR SPACE STATION FREEDOM Final Report, 1 Jan. 1990 - 30 Jun.1992**
Peter W. Barber, Nabeel A. O. Demerdash, B. Hurysz, Z. Luo, Hugh W. Denny (Georgia Tech Research Inst., Atlanta.), David P. Millard (Georgia

Tech Research Inst., Atlanta.), R. Herkert (Georgia Tech Research Inst., Atlanta.), and R. Wang 1992 101 p
(Grant NAG3-1126)
(NASA-CR-192281; NAS 1.26:192281) Avail: CASI HC A06/MF A02

The goal of this research project was to analyze the potential effects of electromagnetic interference (EMI) originating from power system processing and transmission components for Space Station Freedom. The approach consists of four steps: (1) developing analytical tools (models and computer programs); (2) conducting parameterization (what if?) studies; (3) predicting the global space station EMI environment; and (4) providing a basis for modification of EMI standards. Derived from text

**N93-19899#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**A METHOD TO PREDICT THE ORBITAL LIFETIMES OF FREE TETHERS AND TETHER-TRAILING SATELLITES USING ARTIFICIAL NEURAL NETWORKS Ph.D. Thesis**
Ted W. Warnock 28 Aug. 1992 260 p
(AD-A258547; AFIT/CI/CIA-92-017D) Avail: CASI HC A12/MF A03

This dissertation deals with the development of a method to predict the orbital lifetimes of uncontrolled free tethers and tether-trailing satellites originating in low-to-moderate altitude Earth orbits. The problem is solved by application of the empirical method. Two mathematical models to simulate the orbital evolution of tethered systems are developed. In both models the system is discretized into a series of interconnected point masses, orbiting an oblate Earth and transiting an oblate, rotating, temporally, and globally averaged atmosphere. For aerodynamic drag calculations, tether segments are modeled as right circular cylinders, and any end-body is modeled as a sphere. Drag coefficients vary as a function of shape and Knudsen number. In the multibody model, connections between masses are elastic, and the system is free to assume any orientation. Newtonian equations of motion are numerically integrated. In the orbital element propagation model, connections between masses are inelastic, and the system is constrained to remain aligned along the local vertical. Gauss form of Lagrange's Planetary Equations, in terms of equinoctial elements, are used to propagate the orbital elements describing the orbit of the system's center of mass. GRA

**N93-19293#** Mitsubishi Heavy Industries Ltd., Tokyo (Japan).
**CODE DEVELOPMENT FOR HYPERSONIC REAL-GAS FLOW SIMULATIONS TOWARD THE DESIGN OF SPACE VEHICLES [KUURIKI SEKKEI TSURU TOSHITE NO GOKU CHOUONSOKURYUU KEISAN KODO NO KAIHATSU]**
Masahiro Nakao and Kozo Fujii (Tokyo Univ., Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 129-133 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

## 19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

## 20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

**N93-17941*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**PASSIVE RECIRCULATION IN THE NATIONAL LAUNCH SYSTEM'S FUEL FEEDLINES**
W. R. Wilson and K. A. Holt Jan. 1993 31 p
(NASA-TM-108391; NAS 1.15:108391) Avail: CASI HC A03/MF A01

This report contains the passive recirculation tests on the fuel feedline of the National Launch System (NLS). The majority of testing was performed in February 1992, at the National Institute of Standards and Technology in Boulder, CO. The primary objective was to characterize passive recirculation in the NLS fuel feedline. The objective was met by observing the passive recirculation in a one-fifth scale model of the feedline with clear glass sections. The testing was recorded on video tape and with photographs. A description of the testing apparatus and support equipment is included. The experiment indicates that passive recirculation was occurring; higher angles from the horizontal transfer more heat. Author

**N93-17993#** United Technologies Research Center, East Hartford, CT.
**A COMPUTATIONAL STUDY OF A SUPERSONIC MIXER-EJECTOR EXHAUST SYSTEM**
T. J. Barber 10 Nov. 1992 41 p
(AD-A258456; R92-957930) Avail: CASI HC A03/MF A01

An analytical model of the mixer ejector based on a PNS solver approach was used to analyze the flowfield downstream of a supersonic mixer-ejector exhaust system. The method has been used previously to analyze the plume flowfield of unshrouded mixer-type nozzles as well as the flowfield within the mixing duct of a mixer-ejector exhaust system. Calculations are presented for a model-scale exhaust system operating at takeoff flight conditions. Favorable comparisons with total temperature and pressure experimental data are presented in the text. In addition parametric studies are presented examining the importance of turbulence level, streamwise vorticity, grid resolution, etc. on the downstream plume mixing characteristics. Finally, a series of calculations examining the effect of engine power setting (operating condition) and exhaust system size (full scale) are analyzed. GRA

**N93-17995*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**LASER RAYLEIGH AND RAMAN DIAGNOSTICS FOR SMALL HYDROGEN/OXYGEN ROCKETS**
Wilhelmus A. deGroot and Frank J. Zupanc (Sverdrup Technology, Inc., Brook Park, OH.) 16 Jan. 1993 17 p Prepared for the SPIE International Symposium on Lasers, Sensors, and Applications, Los Angeles, CA, 16-23 Jan. 1993; Sponsored by the Society of Photo-Optical Instrumentation Engineers
(RTOP 506-42-31)
(NASA-TM-105999; E-7540; NAS 1.15:105999) Avail: CASI HC A03/MF A01

Localized velocity, temperature, and species concentration measurements in rocket flow fields are needed to evaluate predictive computational fluid dynamics (CFD) codes and identify causes of poor rocket performance. Velocity, temperature, and total number density information have been successfully extracted from spectrally resolved Rayleigh scattering in the plume of small hydrogen/oxygen rockets. Light from a narrow band laser is scattered from the moving molecules with a Doppler shifted frequency. Two components of the velocity can be extracted by observing the scattered light from two directions. Thermal broadening of the scattered light provides a measure of the temperature, while the integrated scattering intensity is proportional to the number density. Spontaneous Raman scattering has been used to measure temperature and species concentration in similar plumes. Light from a dye laser is scattered by molecules in the rocket plume. Raman spectra scattered from major species are resolved by observing the inelastically scattered light with linear array mounted to a spectrometer. Temperature and oxygen concentrations have been extracted by fitting a model function to the measured Raman spectrum. Results of measurements on small rockets mounted inside a high altitude chamber using both diagnostic techniques are reported. Author

**N93-18058*#** Bio-Imaging Research, Inc., Lincolnshire, IL.
**SLIT SCAN RADIOGRAPHIC SYSTEM FOR INTERMEDIATE SIZE ROCKET MOTORS Final Report No. 5, 24 May 1991 - 28 Sep. 1992**
Richard T. Bernardi and David D. Waters 1 Dec. 1992 63 p Original contains color illustrations

(Contract NAS8-38954; SBIR-11.04-6425)
(NASA-CR-191798; NAS 1.26:191798) Avail: CASI HC A04/MF A01; 3 functional color pages

The development of slit-scan radiography capability for the NASA Advanced Computed Tomography Inspection System (ACTIS) computed tomography (CT) scanner at MSFC is discussed. This allows for tangential case interface (bondline) inspection at 2 MeV of intermediate-size rocket motors like the Hawk. Motorized mounting fixture hardware was designed, fabricated, installed, and tested on ACTIS. The ACTIS linear array of x-ray detectors was aligned parallel to the tangent line of a horizontal Hawk motor case. A 5 mm thick x-ray fan beam was used. Slit-scan images were produced with continuous rotation of a horizontal Hawk motor. Image features along Hawk motor case interfaces were indicated. A motorized exit cone fixture for ACTIS slit-scan inspection was also provided. The results of this SBIR have shown that slit scanning is an alternative imaging technique for case interface inspection. More data is required to qualify the technique for bondline inspection. Author

**N93-18078#** Societe Europeenne de Propulsion, Vernon (France).
**ROCKET ENGINE MONITORING SYSTEM: APPLICATION TO THE VULCAIN ENGINE [SYSTEME DE SURVEILLANCE D'UN MOTEUR FUSEE: APPLICATION AU MOTEUR VULCAIN]**
Laurent Delange, Michel Delanoue, and Claire Torquet 1992 4 p In FRENCH Presented at Colloque Lambda-Mu, Grenoble, France, 6-8 Oct. 1992
(ETN-93-93016) Avail: CASI HC A01/MF A01

A monitoring system to ensure safety during future manned flights of Ariane 5 is proposed. This system is required to be operational and capable of stopping the engine before a failure turns disastrous and to be compatible with high requirements. These requirements are addressed and include: high ratio between detected failures and all failures, high reliability, and maximal number of detectors. Results of tests of the detecting algorithm are presented. The detecting algorithm is also applied to the Vulcain engine and the Ariane 5 cryotechnic engine, and results of simulation flights are presented. ESA

**N93-18082#** Societe Europeenne de Propulsion, Vernon (France).
**VULCAIN: A CRYOGENIC ENGINE FOR ARIANE 5**
J. Gastal and J. R. L. Barton 1992 12 p Presented at Hydrogen 1992, Paris, France, 22-25 Jun. 1992
(ETN-93-93022) Avail: CASI HC A03/MF A01

The Vulcain cryogenic engine which will power the main stage of Ariane 5 is considered. The engine operation, its main technical characteristics, and the development activities are described. Emphasis is put on features induced by the use of liquid oxygen and especially Liquid Hydrogen (LH): start up procedures; ignition of the combustion; material choice; mastering LH2 leakages; and safety studies. The development status and program milestones are presented. ESA

**N93-18085*#** Eloret Corp., Sunnyvale, CA.
**EXPERIMENTAL INVESTIGATION OF NOZZLE/PLUME AERODYNAMICS AT HYPERSONIC SPEEDS Progress Report, 1 Feb. - 30 Nov. 1992**
K. Heinemann, David W. Bogdanoff, and Jean-Luc Cambier (Eloret Corp., Sunnyvale, CA.) 3 Dec. 1992 150 p
(Contract NCC2-487)
(NASA-CR-191368; NAS 1.26:191368) Avail: CASI HC A07/MF A02

The work performed by D. W. Bogdanoff and J.-L. Cambier during the period of 1 Feb. - 31 Oct. 1992 is presented. The following topics are discussed: (1) improvement in the operation of the facility; (2) the wedge model; (3) calibration of the new test section; (4) combustor model; (5) hydrogen fuel system for combustor model; (6) three inch calibration/development tunnel; (7) shock tunnel unsteady flow; (8) pulse detonation wave engine; (9) DCAF flow simulation; (10) high temperature shock layer simulation; and (11) the one dimensional Godunov CFD code. For individual title, see N93-18086.

**N93-18086*#** Eloret Corp., Sunnyvale, CA.
**INCREASE OF STAGNATION PRESSURE AND ENTHALPY IN SHOCK TUNNELS** **c02**
David W. Bogdanoff and Jean-Luc Cambier *In its* Experimental Investigation of Nozzle/Plume Aerodynamics at Hypersonic Speeds 3 Dec. 1992 46 p (For primary document see N93-18085 06-20)
(Contract NCC2-487)
Avail: CASI HC A03/MF A02

High stagnation pressures and enthalpies are required for the testing of aerospace vehicles such as aerospace planes, aeroassist vehicles, and reentry vehicles. Among the most useful ground test facilities for performing such tests are shock tunnels. With a given driver gas condition, the enthalpy and pressure in the driven tube nozzle reservoir condition can be varied by changing the driven tube geometry and initial gas fill pressure. Reducing the driven tube diameter yields only very modest increases in reservoir pressure and enthalpy. Reducing the driven tube initial gas fill pressure can increase the reservoir enthalpy significantly, but at the cost of reduced reservoir pressure and useful test time. A new technique, the insertion of a converging section in the driven tube is found to produce substantial increases in both reservoir pressure and enthalpy. Using a one-dimensional inviscid full kinetics code, a number of different locations and shapes for the converging driven tube section were studied and the best cases found. For these best cases, for driven tube diameter reductions of factors of 2 and 3, the reservoir pressure can be increased by factors of 2.1 and 3.2, respectively and the enthalpy can be increased by factors of 1.5 and 2.1, respectively. Author

**N93-18144#** Societe Europeenne de Propulsion, Vernon (France). Liquid Propulsion Div.
**CONCEPTUAL DESIGN OF A HIGH THRUST VULCAIN-DERIVED LOW-COST ROCKET ENGINE**
A. Beaurain, J. Berque, and J. P. Joubert 1992 8 p Presented at AIAA Congress, Nashville, TN, 6-8 Jul. 1992 Previously announced in IAA as A92-49009
(ETN-93-93018) Avail: CASI HC A02/MF A01

The current status of a liquid propelled rocket engine conceptual design program undertaken in order to meet the low cost, high reliability requirements associated with future launching services, is reported. Studies performed in accordance with the following criteria are presented: reduced number of parts, integrated in a simplified architecture, use of low cost materials and manufacturing processes. These concentrate on the engine cycle and operating parameters determination, as well as on the design of main subsystems, such as the field turbopump, the gas generator, the nozzle extension and the valves. The engine overall layout, designed to make it as accessible as possible and hence reduce operational costs, is considered. ESA

**N93-18145#** Societe Europeenne de Propulsion, Vernon (France). Div. Grosse Propulsion a Liquides.
**THE VULCAIN MK2 ENGINE FOR ARIANE 5 PERFORMANCE IMPROVEMENT**
C. Bonniot 1992 7 p Presented at AIAA Congress, Nashville, TN, 6-8 Jul. 1992 Previously announced in IAA as A92-49008
(ETN-93-93019) Avail: CASI HC A02/MF A01

The Ariane 5 MK2 configuration is presented together with the status of the Vulcain MK2 engine, an updated derivative of the Vulcain engine for use on an Ariane 5 MK2 launcher, and subsystem studies (thrust chamber, hydrogen and oxygen tubopump, gas generator). The new Ariane 5 MK2 launcher, available at the end of the year 2000, will offer a 10 to 15 percent payload gain compared to Ariane 5 with no increase in launch cost. ESA

**N93-18146#** Societe Europeenne de Propulsion, Vernon (France). Liquid Propulsion Div.
**HM7 TURBOPUMP CMC STATOR TRIALS**
J. Berque and J. M. Georges (Societe Europeenne de Propulsion, Bordeaux, France ) 1992 9 p Presented at ASME, Cologne, Germany, Jun. 1992
(ETN-93-93021) Avail: CASI HC A02/MF A01

Various tests performed in two Ceramic Matrix Composite (CMC) stators are described together with a few details about the technologies employed to manufacture these test parts. Both stators possessed the same overall geometry as the actual metallic part used in the turbine second stage of the HM7 liquid rocket engine turbopump. The objective was to increase the operating temperatures significantly, and simulate the thermal shock that occurs during the chilldown at the end of the combustion phase. The

stators sustained tests during cumulated periods of 21 and 51 minutes respectively. Both parts went through 15 minute runs, with upstream combustion gases quickly reaching temperatures of about 1700K. ESA

**N93-18201#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**PLUME: INSTRUCTIONS FOR USE AND DESCRIPTION OF A MISSILE PLUME VISIBILITY PROGRAM**
W. B. Cushman, J. S. Marsh (University of West Florida, Pensacola.), S. E. Shamma (University of West Florida, Pensacola.), and S. Schallhorn Jan. 1992 47 p
(NR Proj. M00-96)
(AD-A258201; NAMRL-Monograph-44) Avail: CASI HC A03/MF A01

A computer program to demonstrate the ballistics and visual geometry of an air-to-air missile as it is launched against the observer has been developed. This program calculates the probability of visual detection for various mission scenarios as entered by the user. This manual provides detailed instruction for the user and also describes the logic used to develop the program. GRA

**N93-18235#** Phillips Lab., Hanscom AFB, MA.
**THE ROCKET ELECTRIC FIELD SOUNDING (REFS) PROGRAM: PROTOTYPE DESIGN AND SUCCESSFUL FIRST LAUNCH Report, Dec. 1989 - Sep. 1991**
J. C. Willett, D. C. Curtis, A. R. Driesman, R. K. Longstreth, W. Rison (New Mexico Inst. of Mining and Technology, Socorro.), W. P. Winn (New Mexico Inst. of Mining and Technology, Socorro.), and J. J. Jones (New Mexico Inst. of Mining and Technology, Socorro.) 15 Jan. 1992 126 p Prepared in cooperation with New Mexico Institute of Mining and Technology, Socorro, NM
(AD-A257762; AD-E201266; PL-TR-92-2015; IP-342; XC-PL/HANSCOM) Avail: CASI HC A07/MF A02

The motivation, design, and successful first flight of a sounding rocket to measure profiles of vector electrostatic field in the lower troposphere are described. The design employs eight shutter field mills amd a corona-charging system in a manner similar to aircraft previously instrumented for the measurement of electric fields. A rocket offers significant advantages over an aircraft in simplicity and calibration. A single cylindrical rotor covering most of the payload acts as the shutter for all eight mills in this design. The cylindrical symmetry and circular cross sections of the vehicle facilitate straightforward calibration. Also included in the payload are a pressure sensor, a longitudinal accelerometer, a transverse magnometer, and a novel cloud-penetration detector. A fair-weather test flight at the NASA Wallops Flight Facility demonstrated the workability of the basic design and identified a few necessary modifications. GRA

**N93-18330#** Societe Europeenne de Propulsion, Vernon (France). Liquid Propulsion Div.
**TEST OF A CMC LIQUID PROPULSION ROCKET ENGINE TURBINE STATOR**
J. Berque and J. M. Georges (Societe Europeenne de Propulsion, Bordeaux, France ) 1992 8 p Presented at AIAA Congress, Nashville, TN, 6-8 Jul. 1992 Previously announced in IAA as A92-48766
(ETN-93-93017) Avail: CASI HC A02/MF A01

The succesful testing of two Ceramic Matrix Composite (CMC) stators in conditions fully representative of a cryogenic rocket engine turbine is reported. Both stators possessed the same overall geometry as the actual metallic component used in the turbine second stage of the HM7 engine. They sustained several mid duration tests devoted to combustion parameter tuning and composite material behavior control, before long duration runs, representative of the engine duty cycle. The main objectives were to increase the gas temperature above 1600 K, and to simulate the thermal shock that occurs during the chilldown at the end of the combustion phase, in order to provide a good insight of the benefits in terms of performance, mass, durability and reliability associated with CMC application to a large set of aerospace engine turbines. ESA

**N93-18340#** Photometrics, Inc., Woburn, MA.
**ANALYSIS OF IMAGES AND SPECTRA OF SPACECRAFT-INDUCED RADIATIONS Report No. 2**
D. L. Rall, I. L. Kofsky, and J. A. Gardner 17 Jul. 1992 92 p
(Contract F19628-91-C-0061)
(AD-A257902; PL-TR-92-2178) Avail: CASI HC A05/MF A01

The visible and short wavelength infrared emissions excited from the approximately 110-km altitude atmosphere by the exhaust of solid composite rocket motors of the Bow Shock 2 Experiment (18 Feb 1991) are analyzed and interpreted, and assistance with laboratory measurements of the excitative reactions with ionospheric species of gases from space vehicle operations is reported. A ~10 s-persisting visible wake trail with relatively stable geometry photographed from the 350 km distant Air Force Maui Optical Site is found to be produced by chemiluminescent reactions of a minor Al atom-containing combustion product molecule with ambient oxygen atoms. The much shorter-lived and smaller-volume but several orders of magnitude brighter expanding SWIR glow that Phillips Laboratory/WSSI imaged with a PtSi-photocathode camera at AMOS is identified as the high temperature contact surface with swept-out air of the posigrade-directed thruster exhaust gas. The development of both emitting regions is found to be reasonably well predicted by similarity hydrodynamics for static explosions in the high atmosphere. Absolute optical radiance distributions and yields, and prescriptions for scaling to other exhaust energy deposition rates and altitudes, are presented. GRA

**N93-18401*#** Tennessee Univ. Space Inst., Tullahoma. Center for Space Transportation and Applied Research.
**IDENTIFICATION AND INTERPRETATION OF PATTERNS IN ROCKET ENGINE DATA Semiannual Report No. 3, Aug. 1992 - Jan. 1993**
Ching F. Lo 1993 11 p
(Grant NAG8-166)
(NASA-CR-192100; NAS 1.26:192100) Avail: CASI HC A03/MF A01

The goal of our research is to analyze ground test data, to identify patterns associated with the anomalous engine behavior. On the basis of this analysis, it is the task of our project to develop a Pattern Identification and Detection System which detects anomalous engine behavior in the early stages of fault development significantly earlier than the indication provided by either redline detection mechanism or human expert analysis. Early detection of these anomalies is challenging because of the large amount of noise presence in the data. In the presence of this noise, early indication of anomalies becomes even more difficult to distinguish from fluctuations in normal steady state operation. Author

**N93-18518*#** Alabama Univ., Huntsville. Dept. of Mechanical Engineering.
**ANALYSIS OF FILM COOLING IN ROCKET NOZZLES Semiannual Progress Report, 17 Jan. 1992 - 17 Oct. 1992**
Keith A. Woodbury and Gerald R. Karr 20 Nov. 1992 12 p
(Grant NAG8-212)
(NASA-CR-192003; NAS 1.26:192003) Avail: CASI HC A03/MF A01

Progress during the reporting period is summarized. Analysis of film cooling in rocket nozzles by computational fluid dynamics (CFD) computer codes is desirable for two reasons. First, it allows prediction of resulting flow fields within the rocket nozzle, in particular the interaction of the coolant boundary layer with the main flow. This facilitates evaluation of potential cooling configurations with regard to total thrust, etc., before construction and testing of any prototype. Secondly, CFD simulation of film cooling allows for assessment of the effectiveness of the proposed cooling in limiting nozzle wall temperature rises. This latter objective is the focus of the current work. The desired objective is to use the Finite Difference Navier Stokes (FDNS) code to predict wall heat fluxes or wall temperatures in rocket nozzles. As prior work has revealed that the FDNS code is deficient in the thermal modeling of boundary conditions, the first step is to correct these deficiencies in the FDNS code. Next, these changes must be tested against available data. Finally, the code will be used to model film cooling of a particular rocket nozzle. The third task of this research, using the modified code to compute the flow of hot gases through a nozzle, is described. Author

**N93-18588#** Pacific Northwest Lab., Richland, WA.
**AN INTEGRATED MISSION PLANNING APPROACH FOR THE SPACE EXPLORATION INITIATIVE**
E. P. Coomes, J. E. Dagle, J. A. Bamberger, and K. E. Noffsinger Aug. 1992 4 p Presented at the ANS Meeting, Jackson Hole, WY, 16-19 Aug. 1992
(Contract DE-AC06-76RL-01830)
(DE93-001512; PNL-SA-20524; CONF-9208114-5) Avail: CASI HC A01/MF A01

This report discusses a fully integrated energy-based approach to mission planning which is needed if the Space Exploration Initiative (SEI) is to succeed. Such an approach would reduce the number of new systems and technologies requiring development. The resultant horizontal commonality of systems and hardware would reduce the direct economic impact of SEI and provide an economic benefit by greatly enhancing our international technical competitiveness through technology spin-offs and through the resulting early return on investment. Integrated planning and close interagency cooperation must occur if the SEI is to achieve its goal of expanding the human presence into the solar system and be an affordable endeavor. An energy-based mission planning approach gives each mission planner the needed power, yet preserves the individuality of mission requirements and objectives while reducing the concessions mission planners must make. This approach may even expand the mission options available and enhance mission activities. DOE

**N93-18848*#** RAND Corp., Santa Monica, CA.
**SPACE AND SURFACE POWER FOR THE SPACE EXPLORATION INITIATIVE: RESULTS FROM PROJECT OUTREACH**
C. Shipbaugh, K. Solomon, D. Gonzales, M. Juncosa, T. Bauer, and R. Salter 1991 114 p Sponsored by NASA. Langley Research Center
(Contract F49620-91-C-0003)
(NASA-CR-191254; NAS 1.26:191254; N-3280-AF/NASA) Avail: CASI HC A06/MF A02

The analysis and evaluations of the Space and Surface Power panel, one of eight panels created by RAND to screen and analyze submissions to the Space Exploration Initiative (SEI) Outreach Program, is documented. In addition to managing and evaluating the responses, or submissions, to this public outreach program, RAND conducted its own analysis and evaluation relevent to SEI mission concepts, systems, and technologies. The Power panel screened and analyzed submissions for which a substantial portion of the concepts involved power generation sources, transmission, distribution, thermal management, and handling of power (including conditioning, conversion, packaging, and enhancements in system components). A background discussion of the areas the Power panel covered and the issues the reviewers considered pertinent to the analysis of power submissions are presented. An overview of each of the highest-ranked submissions and then a discussion of these submissions is presented. The results of the analysis is presented. Author

**N93-18856*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SPECTROSCOPIC WEAR DETECTOR Patent**
George C. Madzsar, inventor (to NASA) 16 Feb. 1993 7 p Filed 27 Jun. 1991 Supersedes N91-32167 (29 - 24, p 3968)
(NASA-Case-LEW-15200-1; US-Patent-5,187,542;
US-Patent-Appl-SN-722446; US-Patent-Class-356-300;
US-Patent-Class-73-86; US-Patent-Class-60-223; US-Patent-Class-356-311;
US-Patent-Class-356-36; Int-Patent-Class-G01J-3/00;
Int-Patent-Class-G01N-21/00) Avail: US Patent and Trademark Office

The elemental composition of a material exposed to hot gases and subjected to wear is determined. Atoms of an elemental species not appearing in this material are implanted in a surface at a depth based on the maximum allowable wear. The exhaust gases are spectroscopically monitored to determine the exposure of these atoms when the maximum allowable wear is reached.
Official Gazette of the U.S. Patent and Trademark Office

**N93-18877*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ENVIRONMENTAL INTERACTIONS AND THE SP-100 POWER SYSTEM**
Dale C. Ferguson Jan. 1993 14 p
(RTOP 590-13-51)
(NASA-TM-105866; E-7328; NAS 1.15:105866) Avail: CASI HC A03/MF A01

Interactions of the SP-100 power system with its expected ambient environments are defined. SP-100 payloads will float 100 V negative of the low Earth orbit (LEO) plasma. Choice of proper geometries and materials will prevent arcing at conductor-insulator junctions in LEO. Care in selecting surface coatings will prevent dielectric breakdown. Sputtering is a concern for long-duration LEO missions. Atomic oxygen durability of SP-100 materials will be tested in ground and flight tests. Evaluation of SP-100 in lunar and planetary environments has begun. The report of a recent workshop on Chemical and Electrical Interactions on Mars identified many of the primary interactions. Author

**N93-18878*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**PERFORMANCE AND HEAT TRANSFER CHARACTERISTICS OF A CARBON MONOXIDE/OXYGEN ROCKET ENGINE**
Diane L. Linne Feb. 1993 13 p
(RTOP 506-42-72)
(NASA-TM-105897; E-7521; NAS 1.15:105897) Avail: CASI HC A03/MF A01

The combustion and heat transfer characteristics of a carbon monoxide and oxygen rocket engine were evaluated. The test hardware consisted of a calorimeter combustion chamber with a heat sink nozzle and an eighteen element concentric tube injector. Experimental results are given at chamber pressures of 1070 and 3070 kPa, and over a mixture ratio range of 0.3 to 1.0. Experimental C efficiency was between 95 and 96.5 percent. Heat transfer results are discussed both as a function of mixture ratio and axial distance in the chamber. They are also compared to a Nusselt number correlation for fully developed turbulent flow. Author

**N93-18879*#** Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
**TECHNOLOGY TEST BED ENGINE REAL-TIME FAILURE CONTROL Final Report, Oct. 1992**
Hagop V. Panossian and Victoria R. Kemp 21 Oct. 1992 83 p
(Contract NAS8-40000)
(NASA-CR-192414; NAS 1.26:192414; RSS-8826-28) Avail: CASI HC A05/MF A01

The Real-Time Failure Control (RTFC) program involves development of a failure detection algorithm, for the Space Shuttle Main Engine (SSME). This failure detection approach is signal-based and entails monitoring SSME measurement signals based on predetermined as well as on-line computed mean and standard deviation values. Twenty-four engine measurements are monitored in the algorithm and provisions are made to add more parameters if needed. Each of the first values of every measurement signal at the algorithm start is checked against safety limits placed around a pre-computed engine-to-engine mean value (MV) with a bandwidth equal to a given multiple of the pre-computed standard deviation (SD). If several parameters are out of the bounds of these limits a failure is signaled. During the first two seconds (after algorithm start) a moving average (MA) and a SD is computed on-line in real-time. The moving average of each parameter is computed by averaging the incoming signal measurement with the four most recent previous signal measurements. The moving average is updated at every sampling interval (40 msec) and is checked against a similar safety band around the initial signal value for each parameter. If several anomalies are registered, a failure is signaled by the algorithm. At the end of the two-second interval the MA is fixed as the mean value for the rest of the algorithm operation and a safety band is placed above and below this value equal to a multiple of the computed SD. However, the safety band is adjusted by adjusting the mean value when propellant tank repressurization and venting take place. 'Influence Coefficients' are used to make the necessary adjustments to the safety limits of those parameters that are affected by repressurization and venting or valve closure and opening. The MA is, in both cases, continuously updated and checked against the safety band. Once more, if several parameters exceed the limits a failure is signaled. At the start of every scheduled power transient the algorithm is stopped. It is re-initiated after two seconds from the termination of the power transient and the process is repeated. The final report is divided into four major sections. The most encompassing of all is the discussion section that has sub-sections on: (1) RTFC algorithm development, (2) RTFC simulations; (3) RTFC current limitations; and (4) enhancements planned for. Author

**N93-19106*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**PROGRAM ELM: A TOOL FOR RAPID THERMAL-HYDRAULIC ANALYSIS OF SOLID-CORE NUCLEAR ROCKET FUEL ELEMENTS**
James T. Walton Nov. 1992 50 p
(RTOP 593-71-00)

(NASA-TM-105867; E-7330; NAS 1.15:105867) Avail: CASI HC A03/MF A01

This report reviews the state of the art of thermal-hydraulic analysis codes and presents a new code, Program ELM, for analysis of fuel elements. ELM is a concise computational tool for modeling the steady-state thermal-hydraulics of propellant flow through fuel element coolant channels in a nuclear thermal rocket reactor with axial coolant passages. The program was developed as a tool to swiftly evaluate various heat transfer coefficient and friction factor correlations generated for turbulent pipe flow with heat addition which have been used in previous programs. Thus, a consistent comparison of these correlations was performed, as well as a comparison with data from the NRX reactor experiments from the Nuclear Engine for Rocket Vehicle Applications (NERVA) project. This report describes the ELM Program algorithm, input/output, and validation efforts and provides a listing of the code. Author

**N93-19649*#** Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.

**FIBEROPTIC CHARACTERISTICS FOR EXTREME OPERATING ENVIRONMENTS Final Report, 13 Apr. 1992**

R. C. Delcher 29 May 1992 136 p

(Contract NAS3-25346)

(NASA-CR-189189; NAS 1.26:189189; RI/RD90-115) Avail: CASI HC A07/MF A02

Fiberoptics could offer several major benefits for cryogenic liquid-fueled rocket engines, including lightning immunity, weight reduction, and the possibility of implementing a number of new measurements for engine condition monitoring. The technical feasibility of using fiberoptics in the severe environments posed by cryogenic liquid-fueled rocket engines was determined. The issues of importance and subsequent requirements for this use of fiberoptics were compiled. These included temperature ranges, moisture embrittlement succeptability, and the ability to withstand extreme shock and vibration levels. Different types of optical fibers were evaluated and several types of optical fibers' ability to withstand use in cryogenic liquid-fueled rocket engines was demonstrated through environmental testing of samples. This testing included: cold-bend testing, moisture embrittlement testing, temperature cycling, temperature extremes testing, vibration testing, and shock testing. Three of five fiber samples withstood the tests to a level proving feasibility, and two of these remained intact in all six of the tests. A fiberoptic bundle was also tested, and completed testing without breakage. Preliminary cabling and harnessing for fiber protection was also demonstrated. According to cable manufacturers, the successful -300 F cold bend, vibration, and shock tests are the first instance of any major fiberoptic cable testing below roughly -55 F. This program has demonstrated the basic technical feasibility of implementing optical fibers on cryogenic liquid-fueled rocket engines, and a development plan is included highlighting requirements and issues for such an implementation. Author

**N93-19652*#** Sverdrup Technology, Inc., Brook Park, OH. Research Center Group.

**NASA REQUIREMENTS AND APPLICATIONS ENVIRONMENTS FOR ELECTRICAL POWER WIRING**

Mark W. Stavnes and Ahmad N. Hammoud Cleveland, OH Aug. 1992 11 p Presented at the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, 3-7 Aug. 1992; sponsored by SAE, ACS, AIAA, IEEE, AIChE, and ANS

(Contract NAS3-25266; RTOP 323-57-4A)

(NASA-CR-191064; E-7569; NAS 1.26:191064) Avail: CASI HC A03/MF A01

Serious problems can occur from insulation failures in the wiring harnesses of aerospace vehicles. In most recorded incidents, the failures have been identified to be the result of arc tracking, the propagation of an arc along wiring bundles through degradation of insulation. Propagation of the arc can lead to the loss of the entire wiring harness and the functions which it supports. While an extensive database of testing for arc track resistant wire insulations has been developed for aircraft applications, the counterpart requirements for spacecraft are very limited. The electrical, thermal, mechanical, chemical, and operational requirements for specification and testing of candidate wiring systems for spacecraft applications is presented. Author

**N93-19825*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**NASA'S ADVANCED SOLID ROCKET MOTOR Abstract Only**

Royce E. Mitchell [1993] 1 p Proposed for presentation at the Thirtieth Space Congress, Cocoa Beach, FL, 27-30 Apr. 1993

(NASA-CR-191950; NAS 1.26:191950) Avail: CASI HC A01/MF A01

The Advanced Solid Rocket Motor (ASRM) will not only bring increased safety, reliability and performance for the Space Shuttle Booster, it will enhance overall Shuttle safety by effectively eliminating 174 failure points in the Space Shuttle Main Engine throttling system and by reducing the exposure time to aborts due to main engine loss or shutdown. In some missions, the vulnerability time to Return-to-Launch Site aborts is halved. The ASRM uses case joints which will close or remain static under the effects of motor ignition and pressurization. The case itself is constructed of the weldable steel alloy HP 9-4-0.30, having very high strength and with superior fracture toughness and stress corrosion resistance. The internal insulation is strip-wound and is free of asbestos. The nozzle employs light weight ablative parts and is some 5,000 pounds lighter than the Shuttle motor used to date. The payload performance of the ASRM-powered Shuttle is 12,000 pounds higher than that provided by the present motor. This is of particular benefit for payloads delivered to higher inclinations and/or altitudes. The ASRM facility uses state-of-the-art manufacturing techniques, including continuous propellant mixing and direct casting. Author

**N93-18482#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**PROPULSION DIAGNOSTICS**

S. W. Janson, M. W. Crofton, R. P. Welle, and R. B. Cohen *In its* Aerospace Sponsored Research 1 Dec. 1991 p 76-79 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

**N93-19410*#** University of Central Florida, Orlando. Dept. of Materials Science and Engineering.

**A LOGISTICS AND POTENTIAL HAZARD STUDY OF PROPELLANT SYSTEMS FOR A SATURN 5 DERIVED HEAVY LIFT (THREE-STAGE CORE) LAUNCH VEHICLE**

E. Dow Whitney *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 561-591 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

## 23 CHEMISTRY AND MATERIALS (GENERAL)

**N93-18283*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**POLY(1,2,4-TRIAZOLE) VIA AROMATIC NUCLEOPHILIC DISPLACEMENT Patent**

John W. Connell, inventor (to NASA), Paul M. Hergenrother, inventor (to NASA), and Peter Wolf, inventor (to NASA) 26 Jan. 1993 9 p Filed 24 Jan. 1991 Supersedes N92-10066 (30 - 1, p 13)

(NASA-Case-LAR-14440-1; US-Patent-5,182,356;
US-Patent-Appl-SN-650336; US-Patent-Class-528-128;
US-Patent-Class-528-125; US-Patent-Class-528-126;
US-Patent-Class-528-168; US-Patent-Class-528-169;
US-Patent-Class-528-172; US-Patent-Class-528-174) Avail: US Patent and Trademark Office

The primary object of this invention constitutes new compositions of matter and a new process to prepare poly(1,2,4-triazoles) (PT). It concerns new PT, novel monomers, and the process for preparing the same. Another object of the present invention is to provide new PT that are useful as composite matrix resins for aircraft and dielectric interlayers in electronic devices. Another object of the present invention is the composition of several new di(hyproxyphenyl)-1,2,4-triazole monomers. According to the present invention, the foregoing and additional objects were obtained by synthesizing PT by the nucleophilic displacement reaction of di(hydroxyphenyl)-1,2,4-triazole monomers with activated aromatic dihalides. The inherent viscosities of the PT ranged from 1.37 to 3.4 dL/g and the glass transition temperatures ranged from 192 to 216 C. One polymer

exhibited a crystalline melting temperature of 377 C. Thermogravimetric analysis (TGA) showed no weight loss occuring below 300 C in air or nitrogen with a 5 perceet weight loss occuring at approximately 500 C in air and nitrogen. The synthesis of the di(hydroxphenyl)-1,2,4-triazole monomer is represented in an equation. The monomer can be prepared by either of the two routes shown. The chemistry can easily be extended to prepare similar di(hydroxyphenyl)-1,2,4-triazole monomers. The aromatic dihydrazides in some cases are commercially available or readily prepared from hydrazine and a di(acid chloride). The substitution of the hydroxy groups in either type of monomer may be meta-meta, para-para, or para-meta. The general reaction sequence of PT from each type of di(hydroxyphenyl)-1,2,4-triazole monomer is shown.

Official Gazette of the U.S. Patent and Trademark Office

## 24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

For ceramic materials see *27 Nonmetallic Materials.*

**N93-17897#** Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engines and Space Propulsion.

**FIBER COATING BY SPUTTERING FOR HIGH TEMPERATURE COMPOSITES Final Technical Report, 15 May 1989 - 14 Aug. 1992**

M. L. Emiliani 15 Oct. 1992 79 p

(Contract F49620-89-C-0066)

(AD-A258119; PW-FR-21538; AFOSR-92-0960TR) Avail: CASI HC A05/MF A01

The objective of this activity was to support researchers at the University of California at Santa Barbara in their development of micromechanics models and new or improved high temperature composite systems. This was achieved through the application of sputtered and sol-gel coatings onto monolithic metal and ceramic foils and plates, respectively, as well as high strength monofilament ceramic fibers. The base program aided in the identification and deposition numerous different types of coatings for the several composite systems under evaluation at UCSB. At the conclusion of the base program, promising composite systems were identified for further study and processing via continuous sputtering and sol-gel processing. In addition to providing coated materials to UCSB, P and W also engaged in focused studies of coatings found to be promising by UCSB researchers. The base program study examined as-sputtered Y2O3 coatings deposited onto various substrates to understand why this coating improves the toughness of Nb-reinforced TiAl. The option program study characterized tungsten and molybdenum coatings applied by hollow cathode magnetron sputtering, and aluminum oxide coatings applied by sol-gel processing.

GRA

**N93-17920*#** National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

**INTERLAMINAR STRESS ANALYSIS AT THE SKIN/STIFFENER INTERFACE OF A GRID-STIFFENED COMPOSITE PANEL**

J. F. M. Wiggenraad and N. R. Bauld, Jr. (Deutsche Sporthochschule, Cologne, Germany ) 8 Jan. 1991 26 p Presented at 6th International Conference on Composite Structures, Paisley, Scotland, 9-11 Sep. 1991

(Contract NAS1-17925)

(NASA-CR-192177; NAS 1.26:192177; NLR-TP-91011-U; ETN-92-92512) Avail: CASI HC A03/MF A01

Results of an analysis of the interlaminar stress components at the skin wrap, skin core, and wrap core interfaces for an advanced concept stiffened panel, using a global/local finite element procedure are presented. The procedure consists of a global model of two dimensional shell elements that is used to design a grid stiffened panel with blade type stiffeners, a local model of three dimensional solid elements that is used to compute interlaminar stress components, and a scene devised to assign displacement boundary conditions for the local model that are derived from displacement and rotation data of a few nodes of the global model. The influence of various design parameters on the interlaminar stress was studied. The parameters considered were limited to those for which the global model solution was not affected. The interlaminar stresses for this panel design were found to be well below typical tensile normal and shearing strengths of a graphite epoxy material. ESA

**N93-17924*#** Virginia Polytechnic Inst. and State Univ., Blacksburg.

**GEOMETRICALLY NONLINEAR ANALYSIS OF LAMINATED ELASTIC STRUCTURES**

J. N. Reddy, K. Chandrashekhara, and W. C. Chao Jan. 1993 102 p

(Grant NAG3-208; RTOP 505-63-53)

(NASA-CR-191055; E-7533; NAS 1.26:191055) Avail. CASI HC A06/MF A02

This final technical report contains three parts: Part 1 deals with the 2-D shell theory and its element formulation and applications. Part 2 deals with the 3-D degenerated element. These two parts constitute the two major tasks that were completed under the grant. Another related topic that was initiated during the present investigation is the development of a nonlinear material model. This topic is briefly discussed in Part 3. To make each part self-contained, conclusions and references are included in each part. In the interest of brevity, the discussions presented are relatively brief. The details and additional topics are described in the references cited.

Author

**N93-17961#** Naval Postgraduate School, Monterey, CA.

**A NUMERICAL STUDY OF DYNAMIC CRACK PROPAGATION IN COMPOSITES M.S. Thesis**

Erol Babiloglu Sep. 1992 78 p

(AD-A257544) Avail: CASI HC A05/MF A01

A numerical study was performed to investigate the dynamic crack propagation in fibrous composite plates utilizing the finite element method. A rectangular plate of uniform thickness, which had a propagation central crack, was used for the study. The plate was unidirectional composite panel and the load was applied in the longitudinal direction of the composite plate. Fracture energies were calculated for given speeds of cracks. The objective of the study was to examine the effect of different composite material properties, crack speeds, and densities on the fracture energy. The discontinuous node-release technique was used to model the crack propagation. The numerical study showed that the fracture energy was higher for a lower elastic modulus ratio, if all other conditions were held the same. Furthermore, a lower crack propagation velocity or a lower material density resulted in a higher fracture energy, respectively, provided the rest of the parameters held constant.

GRA

**N93-17964#** Naval Postgraduate School, Monterey, CA.

**FLEXURAL WAVE PROPAGATION IN ANISOTROPIC LAMINATES AND INVERSION ALGORITHMS TO RECOVER ELASTIC CONSTANTS USING PHASE VELOCITY MEASUREMENTS M.S. Thesis**

Brian B. Elliott Sep. 1992 67 p

(AD-A257548) Avail: CASI HC A04/MF A01

Knowledge of the elastic properties of composite materials can be an invaluable tool for both the quality assurance of manufacturing techniques and design verification. Recent advances in ultrasonic velocity measurements have demonstrated the ability to recover elastic properties in anisotropic laminates. A simplified experimental setup was investigated to recover the elastic properties based upon the flexural wave propagation in anisotropic laminates. The initial objective of this thesis was to verify flexural wave propagation in composite laminates through the comparison of experimental and theoretical phase velocities. In the second part of this thesis, the experimental phase velocities were used to calculate the elastic properties of the material by inverting the governing equations. The initial method used to recover elastic constants was successful in the recovery of a partial set of the bending and extensional stiffnesses. The inability to recover all bending stiffnesses dictated the investigation of a second method. This method used an iterative method based upon a nonlinear Newton's method to recover the bending stiffnesses. This method did not converge due to the ill conditioning of the solution matrix. Although this method did not converge, it is believed that more robust methods suggest herein would converge to the proper solution.

GRA

**N93-17990#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**METALLO-ORGANIC SOLUTION DEPOSITION OF FERROELECTRIC PZT FILMS**

R. A. Lipeles, M. S. Leung, and D. J. Coleman 9 Sep. 1992 23 p

(Contract F04701-88-C-0089)

(AD-A258345; TR-0090(5945-02)-1; SMC-TR-92-42) Avail: CASI HC A03/MF A01

The metallo-organic solution deposition ((MOSD) or sol-gel) technique can be used for preparing lead zirconate titanate (PZT) ceramics with a wide range of compositions and crystal structures for electro-optical applications. Film morphology is affected by stoichiometry of the film, hydrolysis and polymerization of the sol-gel solution, and thermal treatment of the deposited material. The lattice parameter decreases with the amount of titanium in PZT in agreement with ceramic data. A slight initial excess of lead in the coating solution is found to improve film morphology. Unlike traditional powder ceramic processing techniques, MOSD permits the growth of small uniform grains that are conductive to achieving consistent electronic and optical properties. Our results show that the properties of films prepared by the MOSD process can be tailored to meet the needs of device applications. GRA

**N93-18044** ESDU International Ltd., London (England).
**THICKNESS SELECTION FOR LAMINATED PLATES SUBJECTED TO IN-PLANE LOADS AND BENDING MOMENTS**
Jan. 1993 42 p
(ESDU-92033; ISBN-0-85679-839-8) Avail: ESDU

ESDU 92033 introduces a FORTRAN program provided on disc (uncompiled) in the software volume that will determine a set of orthotropic layer thicknesses to withstand given in-plane loads and bending moments effectively. The program assumes perfect bonding between the layers and applies to lay-ups symmetrical about the plate mid-plane. All layers are of the same composite materials with continuous fiber reinforcement at 0, 90, +45 or -45 degrees to the plate edges. The +45 or -45 degree layers occur as adjacent pairs. A stacking sequence is initially specified and a design procedure determines layer thickness for that lay-up. The procedure thickens or thins layers according to certain rules based on the way they reinforce each other. An initial set of thicknesses is found using the in-plane loads with the 45 degree layers assumed to carry the shear, and the direct loads carried by layers with fibers in the respective directions taking account of different fiber strengths in tension or compression. The sequence of lay-ups is immaterial at that stage. When the moments are applied, account has to be taken of the distance of a layer from the neutral plane and an iterative solution is required using laminated plate theory. The program will provide alternative lay-ups for comparison with the speficied lay-up and also results that take into account practical ply thicknesses where each layer consists of multiples of a specified standard ply thickness. The input to and output from the program are illustrated by three worked examples and input data error checks are explained with warning messages provided. ESDU

**N93-18077#** Naval Postgraduate School, Monterey, CA.
**THERMAL CYCLING BEHAVIOR OF UNIDIRECTIONAL AND CROSS-PLIED P100 Gr/6061 ALUMINUM COMPOSITES M.S. Thesis**
Anthony D. Wiest Sep. 1992 58 p
(AD-A257506) Avail: CASI HC A04/MF A01

The thermal strain response of as-cast samples of 40 percent P100 graphite fiber reinforced 6061 Al composites in the unidirectionally reinforced and the (0/90) cross-plied configuration was studied. Thermal strain hysteresis and residual plastic strain were observed, both changing with continued cycling. The compressive residual plastic strain is attributable primarily to creep deformation due to compressive residual stress in the matrix at elevated temperature. The role of matrix creep in the heating rate dependence of the strain response was studied by measuring strains under isothermal conditions in the absence of applied stresses. Damage mechanisms operative in the composites during thermal cycling, and the impact of ply constraint on the strain response were also evaluated. GRA

**N93-18139*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SECOND GENERATION INTEGRATED COMPOSITE ANALYZER (ICAN) COMPUTER CODE**
Pappu L. N. Murthy, Carol A. Ginty, and Jose G. Sanfeliz Jan. 1993 93 p
(RTOP 505-63-5B)
(NASA-TP-3290; E-6831; NAS 1.60:3290) Avail: CASI HC A05/MF A01

This manual updates the original 1986 NASA TP-2515, Integrated Composite Analyzer (ICAN) Users and Programmers Manual. The various enhancements and newly added features are described to enable the user to prepare the appropriate input data to run this updated version of the ICAN code. For reference, the micromechanics equations are provided in an appendix and should be compared to those in the original manual for modifications. A complete output for a sample case is also provided in a separate appendix. The input to the code includes constituent material properties, factors reflecting the fabrication process, and laminate configuration. The code performs micromechanics, macromechanics, and laminate analyses, including the hygrothermal response of polymer-matrix-based fiber composites. The output includes the various ply and composite properties, the composite structural response, and the composite stress analysis results with details on failure. The code is written in FORTRAN 77 and can be used efficiently as a self-contained package (or as a module) in complex structural analysis programs. The input-output format has changed considerably from the original version of ICAN and is described extensively through the use of a sample problem. Author

**N93-18148#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry (France). Lab. Materiaux et Procedes.
**INTERFACE MICROSTRUCTURE ANALYSIS OF CERAMIC AND METAL-MATRIX COMPOSITES: SAMPLE PREPARATION METHODS AND ANALYTICAL TECHNIQUES**
G. Simon, F. Bois, and G. Bessenay 1991 5 p Presented at 2nd International Conference on Interfacial Phenomena in Composite Materials, 1991
(DS-2154; ETN-93-93378) Avail: CASI HC A01/MF A01

The preparation of a glass ceramic matrix composite sample for fine analysis of its interface microstructure is considered. Since transmission electron microscopy is the most efficient analysis method, samples as thin as 10 to 100 nanometers are required. Because of the nature of material constituents new methodologies that do not generate degradations into the sample were developed. This entails vacuum impregnation of a resin in the porosities and cracks existing in the as manufactured materials. In this way thin foils with a thickness of 200 microns were obtained. If carbon phases exist in the material there may be an interpretation problem to know whether the detected carbon comes from phase existing in the material or if it comes from the resin impregnation of the porosities of the materials during the thin foil preparation. (Impregnation resins are organic compounds: C-O-H). It is suggested that a tracer element be added to the resin composition. If the carbon phase belongs to the material, the tracer element will consequently not be detected in the chemical analysis. ESA

**N93-18178#** Naval Postgraduate School, Monterey, CA.
**OPTIMUM DESIGN OF EXPERIMENTS IN COMPOSITE RELIABILITY M.S. Thesis**
James W. Coleman Jun. 1992 121 p
(AD-A257574) Avail: CASI HC A06/MF A02

Many composite material applications require a high degree of safety and functionality. This demands that reliability be incorporated in composite design. The design prediction of reliability requires a parametric model based on the failure processes in strength and life. The estimation of the model parameters requires large data set usually limited by time and equipment. The objective of this investigation is to provide, via simulation, a statistics based rationale of experiment design. The result enables multiple use of limited equipment through scheduled censoring to optimize information. GRA

**N93-18222#** Fairfax Materials Research, Inc., Alexandria, VA.
**COMPUTER MODELLING OF CYCLIC DEFORMATION OF HIGH-TEMPERATURE MATERIALS**
M. S. Duesbery and N. P. Louat 16 Nov. 1992 30 p
(Contract N00014-91-C-0067)
(AD-A258404) Avail: CASI HC A03/MF A01

Current methods of lifetime assessment leave much to be desired. Typically, the expected life of a full-scale component exposed to a complex environment is based upon empirical interpretations of measurements performed on microscopic samples in controlled laboratory conditions. Extrapolation to the service component is accomplished by scaling laws which, if used at all, are empirical; little or no attention is paid to synergistic interactions between the different components of the real environment. With the increasingly hostile conditions which must be faced in modern aerospace applications, improvement in lifetime estimation is mandated by both cost and safety considerations. This program aims at improving current methods of lifetime assessment by building in the characteristics of the

micromechanisms known to be responsible for damage and failure. The broad approach entails the integration and, where necessary, augmentation of the micro-scale research results currently available in the literature into a macro-scale model with predictive capability. In more detail, the program will develop a set of hierarchically structured models at different length scales, from atomic to macroscopic, at each level taking as parametric input the results of the model at the next smaller scale. In this way, the known microscopic properties can be transported by systematic procedures to the unknown macro-scale region. It may not be possible to eliminate empiricism completely, because some of the quantities involved cannot yet be estimated to the required degree of precision. In this case, the aim will be at least to eliminate functional empiricism. GRA

**N93-18259#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**CARBON AND GRAPHITE MATRICES IN CARBON-CARBON COMPOSITES: AN OVERVIEW OF THEIR FORMATION, STRUCTURE, AND PROPERTIES**

Gerald S. Rellick 23 Oct. 1992 41 p

(Contract F04701-88-C-0089)

(AD-A258386; TR-0091(6935-06)-3; SSD-TR-92-24) Avail: CASI HC A03/MF A01

Carbon-carbon (C/C) composites, so called because they combine carbon-fiber reinforcement in an all-carbon matrix, can best be viewed as part of the broader category of carbon-fiber-based composites, all of which seek to utilize the light weight and exceptional strength and stiffness of carbon fibers. In C/C particularly, the structural benefits of carbon-fiber reinforcement are combined with the high-temperature capability of an all-carbon materials system, making C/C composites the material of choice for severe-environment applications. Their dimensional stability, laser hardness, and low outgassing also make such composites ideal candidates for various space structural applications. In this overview report, the various fiber architectures used in composite fabrication, i.e., the manner in which the fibers are oriented relative to each other, are discussed briefly. However, the main topic is the carbon matrix and leads to a review of the different approaches for obtaining carbon matrices; specifically, the use of chemical vapor deposition (CVD) of carbon from natural gas (methane), coal-tar and petroleum pitches, and thermosetting resins. In the latter two approaches, the pitch- or resin-matrix composite first produced is baked or fired, to pyrolyze the organic matrix and yield a carbon matrix. The structure of the carbon matrix is characterized by a variety of techniques: X-ray diffraction, laser Raman microprobe spectroscopy, density measurements, polarized-light microscopy, and scanning and transmission electron microscopy (SEM and TEM). GRA

**N93-18266#** Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.

**CORROSION RESISTANCE OF METAL MATRIX COMPOSITES Final Report, Mar. 1989 - Oct. 1992**

R. M. Latanision Oct. 1992 27 p

(Contract N00014-89-J-1588)

(AD-A258370) Avail: CASI HC A03/MF A01

This program examined the relationship between processing and chemistry in continuous fiber graphite/aluminum alloy metal mix composites (G/Al MMCs) with particular attention to subsequent effects on electrochemical behavior. In general, anodic polarization of (G/Al MMCs) compared well with mixed electrode model predictions. Deviations were associated with commercial fiber type and interfacial intermetallics. At high anodic overpotentials, graphite fiber oxidation and subsequent crevice formation resulted in large deviations from mixed-potential theory. Zinc ion implantation of graphite fibers was found to reduce the corrosion rate by a factor of twenty in NaCl solutions. Al4C3 hydrolysis was not observed on the time scale of the polarization studies performed. The scanning potential microprobe (SPM) was used to identify cathodic and anodic sites in situ for both model G/Al composites and commercial 0-90 deg interlaminar G/6061 Al MMCs. GRA

**N93-18364#** Illinois Univ., Urbana. Dept. of Civil Engineering.

**MICROMECHANICS-BASED ANALYSIS OF FIBER-REINFORCED LAMINATED COMPOSITES Report, 1 Jan. 1991 - 31 Aug. 1992**

Shahzad Rahman and David A. Pecknold Sep. 1992 179 p *Its* Structural Research Series No. 572

(Contract N00014-86-K-0799)

(AD-A257816; UILU-ENG-90-2012; SRS-572) Avail: CASI HC A09/MF A02

A procedure for three-dimensional nonlinear material modelling of fiber-reinforced laminated composites is presented. The material modelling procedure has a two-level hierarchical structure. At the bottom level, constitutive information about the fiber and the matrix phases are synthesized using a micromechanical model to yield the effective stress-strain response of a unidirectional lamina. At the top level, a three-dimensional lamination scheme is employed which assembles the laminae within a sublaminate, and delivers the effective stress-strain response of the sublaminate. Local stresses and strains in a lamina or in fiber and matrix phases can be recovered from the effective values at any stage. The material modelling procedure enables the use of standard displacement-based finite elements. The matrix material is characterized using nonlinear-elastic Ramberg-Osgood relations. Micromechanical failure criteria are used for determining various modes of failure, including compression kink-banding. The accuracy of the micromechanical model is demonstrated by comparing its predictions with results from other micromechanical models and experimental data. Examples are also presented for laminated structures; the results are in good agreement with analytical and experimental results available in the literature. GRA

**N93-18379*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**FATIGUE OF CONTINUOUS FIBER REINFORCED METALLIC MATERIALS**

W. S. Johnson, M. Mirdamadi (National Academy of Sciences - National Research Council, Hampton, VA.), and J. G. Bakuckas, Jr. (National Academy of Sciences - National Research Council, Hampton, VA.) Feb. 1993 12 p Presented at Fatigue 1993, Montreal, Quebec, May 1993

(RTOP 763-23-41-85)

(NASA-TM-107700; NAS 1.15:107700) Avail: CASI HC A03/MF A01

The complex damage mechanisms that occur in fiber reinforced advanced metallic materials are discussed. As examples, results for several layups of SCS-6/Ti-15-3 composites are presented. Fatigue tests were conducted and analyzed for both notched and unnotched specimens at room and elevated temperatures. Test conditions included isothermal, non-isothermal, and simulated mission profile thermomechanical fatigue. Test results indicated that the stress in the 0 degree fibers is the controlling factor for fatigue life for a given test condition. An effective strain approach is presented for predicting crack initiation at notches. Fiber bridging models were applied to crack growth behavior. Author

**N93-18423#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**METHOD OF PROCESSING COMPOSITES ON A LATEX BASE (DESCRIPTION OF AN INVENTION FOR AN AUTHOR'S CERTIFICATE)**

V. I. Klassen, A. D. Kovtun, and A. M. Farinov 6 Nov. 1992 6 p Transl. into ENGLISH from Russian Patent 427951, 11 Jun. 1972 p 1-2

(AD-A258455; FASTC-ID(RS)T-0518-92) Avail: CASI HC A02/MF A01

A method for processing composites on a latex base which has been processed in a variable or constant magnetic field is presented. Such composites are used in ship building, ship repair operations, and construction. The purpose is to improve the technological and physico-mechanical properties of mastics and adhesives obtained on a latex base. GRA

**N93-18767*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Composite Materials and Structures.

**MICROMECHANICS OF CRENULATED FIBERS IN CARBON/CARBON COMPOSITES M.S. Thesis Interim Report, 1 Jan. 1990 - 31 Dec. 1992**

E. E. Carapella, M. W. Hyer, O. H. Griffin, Jr., and H. G. Maahs Jan. 1993 123 p

(Grant NAG1-343)

(NASA-CR-192170; NAS 1.26:192170; VPI-E-93-01; CCMS-93-01) Avail: CASI HC A06/MF A02

The influence of crenulated noncircular fibers on the micromechanical stress states due to a transverse strain and to a temperature change in carbon/carbon composites is examined using the finite element method. Stresses at the interface of both fully bonded and fully disbonded fibers having two crenulation amplitudes and with two fiber volume fractions are presented. In each case, these interface stresses are compared to stresses

at the interface of circular fibers which have the same degree of disbond and fiber volume fraction and are under the same loading conditions. For the disbonded cases, deformed meshes showing locations of fiber/matrix contact are also included. In addition to the interface stress states, selected composite properties are also computed and compared in each case examined. Interest in studying noncircular fibers stems from a desire to increase the transverse properties of carbon/carbon by introducing a mechanical interlocking between the fiber and the matrix. Results presented here indicate that this interlocking does in fact occur. Evidence from the interface stress data suggests, however, that any possible advantage of this interlocking may be outweighed by the disadvantage of stress concentrations which arise at the interface due to the crenulated geometry of the fibers. Author

**N93-18774*#** Virginia Polytechnic Inst., Blacksburg. Dept. of Engineering Science and Mechanics.

**ANALYSIS AND OPTIMAL DESIGN OF PRESSURIZED, IMPERFECT, ANISOTROPIC RING-STIFFENED CYLINDERS Report, Sep. 1987 - Jun. 1992**

R. Ley, Z. Gurdal, E. Johnson, and J. H. Starnes, Jr. (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) Nov. 1992 264 p

(Grant NAG1-343)

(NASA-CR-191375; NAS 1.26:191375; CCMS-92-17; VPI-E-92-16) Avail: CASI HC A12/MF A03

Development of an algorithm to perform the structural analysis and optimal sizing of buckling resistant, imperfect, anisotropic ring-stiffened cylinders subjected to axial compression, torsion, and internal pressure is presented. The structure is modeled as a branched shell. A nonlinear axisymmetric prebuckling equilibrium state is assumed which is amenable to exact solution within each branch. Buckling displacements are represented by a Fourier series in the circumferential coordinate and finite elements in the axial or radial coordinate. A separate, more detailed analytical model is employed to predict prebuckling stresses in the flange/skin interface region. Results of case studies indicate that a nonlinear prebuckling analysis is needed to accurately predict buckling loads and mode shapes of these cylinders. The enforcement of stability constraints is treated in a way that does not require any eigenvalue analysis. Case studies performed using a combination of penalty function and feasible direction optimization methods indicate that the presence of the axisymmetric initial imperfection in the cylinder wall can significantly affect the optimal designs. Weight savings associated with the addition of two rings to the unstiffened cylinder and/or the addition of internal pressure is substantial when torsion makes up a significant fraction of the combined load state. Assumption of criticality of the stability constraints and neglect of the stress constraints during the optimal sizing of the cylinders produced designs that nevertheless satisfied all of the stress constraints. Subsequent re-sizing of one cylinder to satisfy a violated in-plane matrix cracking constraint resulted in an optimal design that was 49 percent heavier than the optimal design produced when this constraint was ignored. The additional internal pressure necessary to produce a violation of a stress constraint for each optimal design was calculated. Using an unsymmetrically laminated ring flange, a substantial increase in the strength of the flange/skin joint was observed. Author

**N93-18978#** Army Lab. Command, Watertown, MA. Material Technology Lab.

**HIGH TEMPERATURE CHEMISTRY OF FIBERS AND COMPOSITES Final Report**

Donald R. Messier Sep. 1992 38 p

(AD-A258788; MTL-TR-92-62) Avail: CASI HC A03/MF A01

High temperature chemical reactions can decisively affect the preparation and performance of glass and ceramic fibers and composites. Fiber tensile strength can be limited by critical defects resulting from process chemistry and processing of ceramic composites made difficult, if not impossible, by unwanted high temperature reactions. In some cases, however, advantage can be taken of high temperature reactions to form in situ composites. The foregoing points are discussed and illustrated with examples from the author's research and from the literature. GRA

**N93-18984#** Arizona Univ., Tucson.

**ULTRASTRUCTURE PROCESSING OF ADVANCED MATERIALS Final Report, 15 Feb. 1989 - 14 Aug. 1992**

Donald R. Uhlmann Nov. 1992 750 p

(Grant AF-AFOSR-0236-89)

(AD-A258805; AFOSR-92-0977TR) Avail: CASI HC A99/MF A06

This book contains the proceedings of the Fourth International Conference on Ultrastructure Processing of Ceramics, Glasses and Composites, held February 20 - 24, 1989, in Tucson, Arizona. The conference was sponsored by the Department of Materials Science and Engineering, College of Engineering and Mines, University of Arizona, and supported by the Directorate of Chemical and Atmospheric Sciences of the Air Force Office of Scientific Research (AFOSR). More than 250 scientists and engineers from University industry, and government laboratories attended and included participants from the United States, Great Britain, Japan, France, Italy, Germany, Canada, Brazil, and Spain. Forty-two papers were presented orally, and an additional seventy-three papers were presented at a poster session. GRA

**N93-18988#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**SOLVING NONLINEAR COMPOSITE MATERIAL PROBLEMS USING THE AUTOMATED STRUCTURAL OPTIMIZATION SYSTEM (ASTROS) M.S. Thesis**

Robert Bolha Dec. 1992 89 p

(AD-A258811; AFIT/GA/ENY/92D-14) Avail: CASI HC A05/MF A01

Most advanced composite materials have nonlinear stress versus strain curves--grossly so in the laminas shear direction. If linear approximations are used, overly conservative design will result. This thesis expands the usefulness of the Automated Structural Optimization System (ASTROS) finite element (FE) program by incorporating a newly developed capability to include material nonlinearities. By dividing a FE problem into several intervals, and incorporating the changing nature of the nonlinear material properties within each element, a good approximation of the laminate's actual stresses and strains can be obtained without the undue experimentation involved in testing every individual configuration. Each material property is updated in terms of tension and compression as appropriate. Updating the material properties is possible in the material axes through comparison to cubic spline curves made from experimental data. The resulting piecewise linear analysis accurately captures the nonlinear nature of the properties. This research considered plane stress flat plates with and without holes. Graphite/Polyetheretherketone is an advanced composite material that has good high temperature strength properties and nonlinear material properties. GRA

**N93-19022*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**SANDWICHED STRUCTURAL PANEL HAVING A BI-DIRECTIONAL CORE STRUCTURE Patent Application**

Bruce Weddendorf, inventor (to NASA) 8 Jan. 1993 13 p

(NASA-Case-MFS-28796-1; NAS 1.71:MFS-28796-1;

US-Patent-Appl-SN-002002) Avail: CASI HC A03/MF A01

A structural panel assembly has a bi-directional core structure sandwiched between and secured to a pair of outer side wall members. The core structure is formed from first and second perpendicular series of elongated strip members having crenelated configurations. The strip members in the first series thereof are transversely interwoven with the strip members in the second series thereof in a manner such that crest portions of the strip members in the first series overlie and oppose trough portions of the strip members in the second series, and trough portions of the strip members in the first series underlie and oppose crest portions of the strip members in the second series. The crest portions of all of the strip members lie generally in a first plane and are secured to the inner side of one of the panel assembly outer side walls, and the trough portions of all of the strip members lie generally in a second plane and are secured to the inner side of the other panel assembly outer side wall. NASA

**N93-19032** Washington Univ., Seattle.

**A COMBINED EXPERIMENTAL ANALYTICAL METHODOLOGY FOR CHARACTERIZING THE THERMOVISCOPLASTIC DEFORMATION OF A METAL MATRIX COMPOSITE Ph.D. Thesis**

John Robert Rogacki 1992 248 p

Avail: Univ. Microfilms Order No. DA9239491

This dissertation research investigates the response of a fiberless thirteen layer hot isostatically pressed Ti-15-3 laminate to creep, constant

strain rate, and cyclic constant strain rate loading at temperatures ranging from 482 C to 649 C. Creep stresses from 48 to 260 MPa and strain rates of .0001 to .01 m/m/sec were used. Material parameters for three unified constitutive models (Bodner Partom, Miller, and Walker models) were determined for Ti-15-3 from the experimental data. Each of the three models was subsequently incorporated into a rule of mixtures and evaluated for accuracy and ease of use in predicting the thermoviscoplastic response of unidirectional metal matrix composite laminates (both 0 and 90 degree). The laminates were comprised of a Ti-15-3 matrix with 29 volume percent SCS(sub 6) fibers. The predicted values were compared to experimentally determined creep and constant strain rate data. It was found that the three models generally agreed with the 0 degree data, but a suspected weak fiber-matrix interface caused the models to overestimate the stiffness of the laminates in the transverse direction. Dissert. Abstr.

**N93-19043** Washington State Univ., Pullman.
**CIRCULAR DISLOCATION LOOPS AND THEIR APPLICATION TO THE MICROMECHANICS OF FIBROUS COMPOSITES Ph.D. Thesis**
Ismail Demir 1992 143 p
Avail: Univ. Microfilms Order No. DA9238394

An analytical approach is proposed in this work for addressing a number of problems related to the micromechanical response of homogeneous and fibrous composite materials which have some imperfections such as circular crystal defects, broken fibers, fiber-matrix debonding and interfacial cracks. The approach rests upon utilizing the generalized Somigliana theory of dislocation and the use of unconventional dislocation loops (rings) to model the three-dimensionality of such problems. These problems are treated within a continuum mechanics framework using the well established linear theory of elasticity. In order to establish a methodology the models are first developed for homogeneous materials. Starting from the field quantities of a single dislocation loop the pile-up and interaction of the loops in homogeneous media are modeled. For this case it is possible to express the final results in a compact form. The same methodology is followed for the more complicated bimaterial case. Because of algebraic complications the results are not expressed in an exact closed form. Thus, a combination of analytical and numerical methods is employed for the bimaterial case and the dislocation pile-up cases. Although the main emphasis in this study is on the circular dislocation loops, it has been shown that it is possible to model more complicated shapes by approximating these loops by the combination of small line dislocation segments. It is anticipated that the method will yield, among other things, evaluation of elastic field of the pileup/crack models for plastic zone near fiber tips and fiber-fiber interactions. Moreover, it is possible to facilitate the method for the solution of various three-dimensional curved inclusions and defects, including fibers with noncircular cross-section. Dissert. Abstr.

**N93-19060** Virginia Univ., Charlottesville.
**CHARACTERIZATION AND DEFECT ANALYSIS OF HIGH TEMPERATURE ALUMINUM-BASED METAL MATRIX COMPOSITES Ph.D. Thesis**
Thomas David Bayha 1991 249 p
Avail: Univ. Microfilms Order No. DA9237634

There is a need for an aluminum-based material to replace titanium in high temperature aerospace applications. Two powder metallurgy (P/M) matrices, RSP Al-8Fe-4Ce and MA Al-9Ti reinforced with 20 volume percent Al2O3 fibers or SiC whiskers or particles were developed for this purpose. Microstructural and mechanical property evaluations of these systems were performed to determine high temperature viability. Elevated temperature tensile tests demonstrated strengths of 14 ksi (98 MPa) at 450 C in the RSP matrix composites reinforced with SiC whiskers; the MA Al-9Ti materials produced tensile strengths of better than 17 ksi (120 MPa) at 500 C. Processing defects contribute significantly to tensile failure at low temperature; Co/SiC defects that result from a sol gel processing step coarsen with exposure to elevated temperature. At elevated temperatures, the failure of all composites was matrix controlled, although some particulate strengthening is evident. A fracture mechanics approach was utilized to determine the plane strain fracture toughness of Al-9Ti/Co/SiC particle reinforced composites; K(sub IC) at room temperature in the as received condition is 4.7 MPa-m(exp 1/2). Fracture toughness increased with annealing at 500 C for 120 and 400 hours. The growth of the intermetallic reaction zone in the Co/SiC particle reinforced materials was found to be parabolic; the rate constants were determined as a function of temperature. Moving boundary theory was applied to determine the interdiffusion coefficient in the intermetallic region as a function of temperature; diffusion is enhanced by a subgrain structure in the reaction zone although a determination of the pre-exponential factor and activation energy for interdiffusion does not show this effect. The pre-exponential interdiffusion coefficient, D(sub 0) is equal to 7.0 x 10(exp 11) sq m/sec and the activation energy for interdiffusion is Q = 99.9 kcal. X-ray linescans across intermetallic reaction zones grown in the material are devoid of any Si or Ti, suggesting that SiC particles and Al3Ti constituents are being swept ahead of the reaction zone/matrix boundary in the solid state. Dissert. Abstr.

**N93-19090#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**BEHAVIOR OF A TITANIUM MATRIX COMPOSITE UNDER QUASI-STATIC TENSILE AND COMPRESSIVE LOADING M.S. Thesis**
Keith L. Bearden Dec. 1992 105 p
(AD-A258828; AFIT/GAE/ENY/92D-07) Avail: CASI HC A06/MF A02

Quasi-Static tensile and compressive testing was performed on a unidirectional titanium matrix composite. The specific material was SCS-9/Beta 21S. The initial tensile and compressive modulus for both laminates was the same. The ninety degree laminate had a tensile and compressive modulus of 115.89 GPa. The zero degree laminate had a tensile and compressive modulus of 197.51 GPa. The ninety degree laminate exhibited a three stage stress/strain response in tension. The first stage is completely linearly elastic, however, partial debonding of the fiber from the matrix was observed. This partial debond did not effect the stress/strain response. The second stage is due to the complete debond of the fiber from the matrix. The ninety degree laminate in compression had a two stage stress/strain response, and the zero degree laminate had a two stage stress/strain response in tension and compression. Plasticity and damage were the main causes of deformation. Plasticity involved deformation of the matrix between the fibers and Poisson's contraction of the matrix from the fibers. Damage involved fiber matrix d matrix cracking and fiber cracking. All of these mechanisms were present, and they were related to the appropriate stress/strain characteristics. GRA

**N93-19091#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**OPEN AND FILLED HOLE STATIC TENSILE STRENGTH CHARACTERIZATION OF METAL MATRIX COMPOSITE SCS-9/BETA21s M.S. Thesis**
Jacob T. Roush Dec. 1992 165 p
(AD-A258829; AFIT/GAE/ENY/92D-12) Avail: CASI HC A08/MF A02

SCS-9/Beta 21s has a reduced gauge thickness, in comparison with other metal matrix composites, due to a smaller diameter fiber. This reduced gauge thickness makes it an attractive candidate for the skin of hypersonic vehicles. Tensile testing of (0/90) sub 2s and (O/+ or -45/90) sub s laminates was performed at room temperature, 482 deg C, and 650 deg C. Both notched and unnotched specimens were tested. Notched specimens, open and filled hole, had a width-to-diameter ratio of six. Materials 7075-T6 and Mar-m-246 were used as pins in the filled hole tensile testing. Analytical work was completed to predict material properties, elastic and plastic stress concentration factors, residual stresses, and failure strengths. Damage was documented in the form of fiber-matrix debonding, matrix cracking, fiber failure, and plasticity. GRA

**N93-19336#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**BEHAVIOR OF A CENTRALLY NOTCHED CROSS-PLY AND UNIDIRECTIONAL CERAMIC MATRIX COMPOSITE IN TENSION-COMPRESSION FATIGUE M.S. Thesis**
William A. Weidenaar Dec. 1992 113 p
(AD-A258907; AFIT/GAE/ENY/92D-26) Avail: CASI HC A06/MF A02

Centrally notched (hole), cross-ply, ((0/90)(sub 2)(sub s)), and unidirectional, (0)(sub 8) laminates of Silicon Carbide fiber-reinforced Aluminosilicate glass, SiC/1723, were fatigue tested under tension-compression loading with a load ratio of -1. Damage accumulated continuously for both lay-ups, leading to eventual failure and a reduced fatigue life. Critical damage in the cross-ply consisted of longitudinal cracks in the 90 deg plies growing and combining with transverse cracks to

effectively eliminate the 90 deg plies' load carrying capability and allowing the specimen to buckle. Critical damage in the unidirectional lay-up consisted of longitudinal cracks which initiated at the shear stress concentration points on the hole periphery. Reversed cyclic loading caused continued crack growth at maximum stresses below the tension-tension fatigue limit. The cross-ply lay-up appeared insensitive to the hole, while critical damage in the unidirectional lay-up was dependent on the shear stress concentrations at the hole. GRA

**N93-19354#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**EFFECT OF THICKNESS AND PLY LAYUP ON THE COLLAPSE CHARACTERISTICS OF CYLINDRICAL COMPOSITE SHELLS WITH LARGE CUTOUTS M.S. Thesis**

James C. Hatfield Dec. 1992 205 p

(AD-A258909; AFIT/GAE/ENY/92D-20) Avail: CASI HC A10/MF A03

This study involved a numerical and experimental investigation of the geometric instability (collapse loads/displacements) of vertically unsupported graphite/epoxy cylindrical shell panels undergoing axial compression. Symmetric quasi-isotropic and cross-ply laminates, with and without 4 x 4 centralized cutouts, were investigated for three thicknesses: 8, 16, and 24 plies. The experimental data was compared to results from SHELL, a geometrically nonlinear finite-element computer program which incorporates a parabolic transverse shear strain distribution through the thickness. Good correlation was obtained for shells with large cutouts between the SHELL numerical data and the experimental results. This research verified that the SHELL program will provide good predictions of the collapse characteristics of shell structures undergoing large displacements and moderately large rotations. It was found that the magnitudes of transverse shear strain increased with increasing panel thickness and increased significantly when a large cutout was placed in a shell. Also, there were indications that under large displacement and moderately large rotation conditions, the collapse of cross-ply shells was more affected by transverse shear strain than the collapse of quasi-isotropic shells. GRA

**N93-19357#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**COMPUTATIONAL AND EXPERIMENTAL INVESTIGATION INTO FRACTURE OF BRITTLE FIBER-BRITTLE MATRIX COMPOSITE SYSTEMS M.S. Thesis**

James P. Solti Dec. 1992 160 p

(AD-A258913; AFIT/GAE/ENY/92D-04) Avail: CASI HC A08/MF A02

Experimental and computational analyses provided an improved understanding of quasi-static fracture in model composite systems. Constant displacement compression tests using borosilicate glass double cleavage drilled compression test templates provided qualitative assessments of localized toughening for crack growth near cylindrical inclusions. Large crack-tip stress fields induced interfacial slip and separation prior to arrival of the main crack. Debonding and the proliferation of secondary matrix cracks characterized the role of bridging fibers along weak interfaces. Strong residual normal compressive interfacial stresses diminished the influence of crack-tip stresses; however, slip was still observed. VHS tape and computer enhanced photos record a history of crack propagation and interfacial slip. Experimental data was used to validate a fully three-dimensional computational code capable of analyzing fracture near and around cylindrical inclusions. Consistent variations in the shape of the crack periphery renders confidence in the elasticity solution. GRA

**N93-19359#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**STRATIFIED PLATE MODEL FOR COMPOSITE PLATE ANALYSIS M.S. Thesis**

Richard A. Coveno Dec. 1992 129 p

(AD-A259001; AFIT/GAE/ENY/92D-29) Avail: CASI HC A07/MF A02

The investigation of the stratified plate model for the analysis of composite plates is continued. The strata theory models a composite plate as a stack of isotropic matrix and orthotropic, fiber dominated layers. Energy methods are used to derive a set of partial differential equations and boundary conditions as a function of the displacement. An assumed displacement field, of a polynomial in z and a sine/cosine function in x and y, generates a solution to a simply supported composite plate with cross plies. A cylindrical bending example is also solved with a polynomial in z and sin/cosine function in x and y displacement. A Ritz polynomial x and y displacement function is used to generate a solution to a composite plate with angle plies. The strata model is expected to be useful for predicting stresses in composites where the matrix material became viscoelastic. Author

**N93-19443#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**BEHAVIOR OF A QUASI-ISOTROPIC PLY METAL MATRIX COMPOSITE UNDER THERMO-MECHANICAL AND ISOTHERMAL FATIGUE LOADING M.S. Thesis**

Karl A. Hart Dec. 1992 170 p

(AD-A258902; AFIT/GAE/ENY/92D-05) Avail: CASI HC A08/MF A02

This study investigated the behavior of the SCS6/Ti-15-3 metal matrix composite with a quasi-isotropic layup when tested under static and fatigue conditions. Specimens were subjected to in-phase and out-of-phase thermo-mechanical and isothermal fatigue loading. In-phase and isothermal loading produced a fiber dominated failure while the out-of-phase loading produced a matrix dominated failure. Also, fiber domination in all three profiles was present at higher maximum applied loads and at three profiles demonstrated matrix domination at lower maximum applied loads. Thus, failure is both profile dependent and load equipment. Additional analyses, using laminated plate theory, Halpin-Tsai equations, METCAN, and the Linear Life Fraction Model (LLFM), showed: the 'as-received' specimens contained plies where a portion of the fibers are debonded from the matrix; during fatigue cycling, the 90 deg. plies and a percentage of the 45 deg. plies failed immediately with greater damage becoming evident with additional cycles; and, the LLFM suggests that there may be a non-linear combination of fiber and matrix domination for in-phase and isothermal cycling. GRA

**N93-19444#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**INVESTIGATION OF FATIGUE BEHAVIOR IN NOTCHED CROSS-PLY TITANIUM METAL MATRIX COMPOSITE AT ELEVATED TEMPERATURE M.S. Thesis**

Robert P. Baker Dec. 1992 170 p

(AD-A258922; AFIT/GAE/ENY/92D-03) Avail: CASI HC A08/MF A02

The objective of this research was to investigate the initiation and progression of damage which develops in notched (0/90) sub 2S SCS-6/Ti-15-3 at elevated temperature. Testing consisted of a monotonic tensile test at 427 C followed by fatigue testing performed under load control with a stress ratio of 0.1 at a frequency of 10 Hz. A crack was defined to have initiated when it had attained a length greater than or equal to 0.124 mm. Crack initiation and progression was monitored by strain and modulus observations and visual inspection via telemicroscope. The cracks were recorded with edge and face replicas. Metallographic and fractographic analysis was performed after specimen failure. Fatigue cracks initiated in the matrix at four locations on the front and back faces of each specimen. Two of these cracks became through-cracks and eventually developed into major cracks which caused the fracture. The applied stress (S) and fatigue lives (N) curves for both initiation and fatigue life were established. Also, crack growth curves as the function of fatigue cycles were established. A detailed metallographic analysis was performed to understand the damage mechanisms and its implication on the observed notched fatigue behavior. GRA

**N93-19839#** Stanford Univ., CA. Dept. of Aeronautics and Astronautics.

**DAMAGE MECHANICS OF CROSS-PLY LAMINATES RESULTING FROM TRANSVERSE CONCENTRATED LOADS Final Report, 1 Oct. 1989 - 30 Sep. 1992**

Sheng Liu and Fu-Kuo Chang 30 Sep. 1992 184 p

(Grant AF-AFOSR-0554-89)

(AD-A259271; AFOSR-93-0001TR) Avail: CASI HC A09/MF A02

An investigation was performed to study damage development in fiber-reinforced laminated composites induced by transverse concentrated loads. The major focus of the study was to understand fundamentally the damage mechanics in terms of matrix cracking and delamination growth and the interaction between them resulting from a transverse concentrated load. The study was focused on cross-ply laminates only, and the load was introduced quasistatically through a cylindrical or spherical indenter. Accordingly, the research was divided into two stages: (1) damage induced

by a cylindrical indenter, and (2) damage induced by a spherical indenter. Analytical models consisting of a contact analysis and a failure analysis were developed for analyzing the damage initiation and growth induced by both loading conditions. Experiments were also performed to generate data needed for the models and to verify the proposed analyses. The predictions based on the models agreed very well with the data. GRA

**N93-19846#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**FATIGUE BEHAVIOR OF A CROSS-PLY CERAMIC MATRIX COMPOSITE UNDER TENSION-TENSION AND TENSION-COMPRESSION LOADING M.S. Thesis**

Frank A. Opalski Dec. 1992 67 p

(AD-A259209; AFIT/GAE/ENY/92D-02) Avail: CASI HC A04/MF A01

A study was conducted which investigated the behavior of a cross-ply ((0/90)(sub 2S)) Nicalon/Calcium-Aluminosilicate (Nicalon/CAS) ceramic matrix composite at room temperature under tension-compression fatigue loading. Material behavior and damage was recorded by stress-strain curves, elastic modulus, hysteretic energy density, and acetate replication techniques. Tension-tension fatigue tests at a load ratio R of 0.1 (R = sigma(min)/sigma(max)) were completed which determined that 140 MPa was the maximum stress allowable in which cycle runout (1,000,000 cycles) would occur. Above this value, transverse crack density increased with respect to cycles and failure ultimately occurred. Tension-compression tests were then performed at load ratios of -2.0, -1.5, and -1.0 with 140 MPa as the maximum tensile stress. In all cases, longitudinal cracks parallel to the loading direction developed. The greater the magnitude of the compressive load, the sooner these longitudinal cracks appeared. Failure always occurred in compression due to buckling of individual plies, thus indicating that tension-compression can significantly reduce fatigue life. Using the elastic modulus as a means of verifying damage was acceptable, but it did not reasonably predict specimen failure. On the other hand, the area under the stress-strain curve (hysteretic energy density) was a better indicator of probable failure since specimens which achieved cycle runout showed either a decreasing or constant energy density while those which failed always showed an increasing value. GRA

**N93-18486#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**NONLINEAR ACOUSTIC-ELECTROMAGNETIC COUPLING IN MATERIALS**

G. F. Hawkins and P. M. Sheaffer *In its* Aerospace Sponsored Research 1 Dec. 1991 p 90-92 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

## 25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

**N93-17910#** California Univ., Los Angeles.

**EVAPORATION AND BURNING OF A SPHERICAL FUEL DROPLET IN A UNIFORM CONVECTIVE FLOWFIELD Ph.D. Thesis**

K. Madooglu 1992 137 p

(Contract DE-FG03-88ER-13910)

(DE93-002223; DOE/ER-13910/T2) Avail: CASI HC A07/MF A02

An analytical/numerical model is developed for the evaporation and burning of a spherical fuel droplet in a subsonic crossflow. The external gaseous flowfield is represented using an approximate compressible potential-flow solution, while the internal flowfield of the droplet is represented by the classical Hill's spherical vortex. This allows a numerical solution for the external boundary layer, from which the droplet's effective drag coefficent, rate of mass loss, size, and the shape of the diffusion flame with infinitely fast chemical reaction kinetics are determined. Subsequently, the quasi-steady model with uniform liquid temperature is extended to examine the effects of the transient heating of the droplet interior. Time-dependent calculations are performed with updated droplet Reynolds numbers and updated surface temperatures. Comparisons of model predictions with experimental data are made. To examine the effects of finite-rate chemical reaction kinetics, a one-step formulation of the combustion mechanism is integrated into the gaseous boundary layer equations. Simplifying assumptions for the variation of gas properties commonly used in combustion calculations, are subjected to an examination as to their degree of accuracy. For this purpose, the droplet model is extended to account for the variation of gas properties with temperature and gas composition within the boundary layer. Comparisons are made between the predictions obtained from the different models developed in this study, as well as with existing experimental data. DOE

**N93-18189#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

**CONTRIBUTION TO THE STUDY OF AIRBREATHING BURNER COMBUSTION INSTABILITIES Ph.D. Thesis - Rouen Univ., 1991 [CONTRIBUTION A L'ETUDE DES INSTABILITIES DE COMBUSTION DES FOYERS AEROBIES]**

Alain Laverdant 1992 350 p In FRENCH

(ONERA-NT-1992-2; ETN-93-93045) Avail: CASI HC A15/MF A03

The effects of radical reactions in combustion instabilities are investigated. Combustion instabilities are essentially due to the interaction between nonlinear acoustic waves, coherent structures and combustion. Acoustic mode computations show the influences of temperature heterogeneities and of geometry. For a nonreactive flow, the interaction of coherent structures and an acoustic mode can induce a resonant mechanism. A numerical simulation, made with an adaptation of a code, partially confirms the experimental results. The interaction between a diffusion flame and a viscous core vortex yields results in good agreement with those of the literature. The calculations are extended to a premixed flame. The acoustic emission is evaluated analytically. A numerical simulation of unsteady combustion on a burner shows the presence of a coherent structure and of a wrinkled flame. ESA

**N93-18290#** Naval Research Lab., Washington, DC.

**DECOMPOSITION OF HALOGENATED ORGANIC MATERIALS BY ELECTRIFIED MICROHETEROGENEOUS CATALYSIS**

Joseph Z. Stemple and Debra R. Rolison 27 Nov. 1992 18 p

(AD-A257984; NRL/MR/6170-92-7165) Avail: CASI HC A03/MF A01

Through the use of electrified microheterogeneous catalysis, which involves the application of electrifying forces to dilute dispersions of catalytically active solids, we have discovered that it is possible to destroy chlorinated aromatic and chlorofluorocarbon species in water at 0 C with applied dc voltages of less than 30 V. Chlorobenzene, Aroclor 6050 (a polychlorinated terphenyl), and CFC-113 (1,1,2-trichloro- trifluoroethane) have all been found to decompose when subjected to dispersion electrolysis in the presence of a zeolitic catalyst suspension. The reaction products are water soluble and were analyzed by gas chromatography, mass spectrometry, and ion chromatography. GRA

**N93-18312#** Politecnico di Milano (Italy).

**INTERNATIONAL WORKSHOP ON MATHEMATICAL METHODS IN COMBUSTION**

22 May 1992 47 p Workshop held in Como, Italy, 18-22 May 1992

(Contract DAJA-45-92-M-0215)

(AD-A258478; R/D-6902-AN-03) Avail: CASI HC A03/MF A01

The following contents are presented: analytical fundamentals; mathematical applications; numerical fundamentals; detonation processes; linear combustion stability; and closure session. GRA

**N93-18411#** California Univ., Berkeley. Lawrence Berkeley Lab.

**ELECTRONIC EXCITED STATES AS A PROBE OF SURFACE ADSORBATE STRUCTURE AND DYNAMICS IN LIQUID XENON Ph.D. Thesis**

E. S. Peterson Aug. 1992 152 p

(Contract DE-AC03-76SF-00098)

(DE93-002550; LBL-32841) Avail: CASI HC A08/MF A02

A combination of second harmonic generation (SHG) and a simple dipole-dipole interaction model is presented as a new technique for determining adsorbate geometries on surfaces. The polarization dependence of SHG is used to define possible geometries of the adsorbate about the surface normal. Absorption band shifts using geometry constraints imposed by SHG data are derived for a dimer constructed from two arbitrarily

placed monomers on the surface using the dipole-dipole interaction potential. These formulae can be used to determine the orientation of the two monomers relative to each other. A simplified version of this formalism is used to interpret absorption band shifts for rhodamine B adsorbed on fused silica. A brief history of the exciton is given with particular detail to Xe. Data are presented for transient absorption at RT in liquid xenon on the picosecond time scale. These are observations of both tunneling through the barrier that separates the free and trapped exciton states and the subsequent trapping of the exciton. In high densities both of these processes are found to occur within 2 to 6 picoseconds in agreement with theories of Kmiecik and Schreiber and of Martin. A threshold density is observed that separates relaxation via single binary collisions and relaxation that proceeds via Martin's resonant energy transfer hopping mechanism. DOE

**N93-18424#** Northwestern Univ., Evanston, IL. Dept. of Chemical Engineering.

**SOLID STATE, SURFACE AND CATALYTIC STUDIES OF OXIDES**

H. H. Kung Dec. 1992 15 p

(Contract DE-FG02-87ER-13725)

(DE93-004640; DOE/ER-13725/6) Avail: CASI HC A03/MF A01

The properties of oxide catalysts that determine selectivity in oxidation of alkanes were investigated. Upon examining the product distribution in the oxidation of ethane, propane, butane, pentane, and cyclohexane over Mg orthovanadate, Mg pyrovanadate, and vanadyl pyrophosphate, it was found that whether dehydrogenation, formation of oxygen-containing organic products, or combustion was the predominant reaction depended on the catalyst and alkane. The product distribution could be explained by considering whether the active sites contained easily removable lattice oxygen ions, and whether the size of the alkane molecule was sufficiently large to be bonded to two adjacent vanadium ions in the active site to enhance the probability of reaction between the adsorbed hydrocarbon intermediate and reactive lattice oxygen. Selectivity for oxidative dehydrogenation of butane on silica-supported vanadium oxide depended on the vanadia loading. The selectivity was much higher on a 1 wt. percent than on a 10 wt. percent V2O5/SiO2 sample. It was also found that on the 10 wt. percent sample, agglomeration of vanadia into V2O5 crystallites occurred during reaction. Results suggested that isolated VO4 units were more selective for dehydrogenation of butane, consistent with the idea that the selectivity depended on the availability of reactive oxygen in the active site. DOE

**N93-18453#** Michigan Univ., Ann Arbor. Dept. of Chemistry.

**HYDROGEN INDUCED C-C, C-N, AND C-S BOND ACTIVATION ON Pt AND Ni SURFACES**

J. L. Gland 1992 3 p

(Contract DE-FG02-91ER-14190)

(DE93-004647; DOE/ER-14190/1) Avail: CASI HC A01/MF A01

The work has focussed on hydrogen induced bond activation in adsorbed organic molecules and intermediates containing C-S and C-N and C-C bonds on Ni(100), Ni(111), and Pt(111) surfaces. Fluorescence Yield Near Edge Spectroscopy (FYNES) above the carbon K edge was used for adsorbed organic reactants and in-situ kinetic studies of bond activation. Results indicate that the activation is enhanced on Ni relative to Pt. Methylthiolate and methylamine adsorbed on Pt(111) were studied. DOE

**N93-18523#** Oak Ridge National Lab., TN.

**PREDICTING VISCOSITIES OF AQUEOUS SALT MIXTURES**

A. Zaltash and M. R. Ally 1992 9 p Presented at the Winter Annual Meeting of the ASME, Anaheim, CA, 8-13 Nov. 1992

(Contract DE-AC05-84OR-21400)

(DE93-002421; CONF-921110-30) Avail: CASI HC A02/MF A01

Viscosity plays an important role in quantifying heat and mass transfer rates as depicted in theoretical and semi-empirical correlations. In practical problems where extreme temperatures and solute concentrations are encountered, viscosity data is usually unavailable. At these conditions, no dependable correlation appears to exist in the literature. The hole type model is used to predict the viscosity of aqueous electrolytes containing single and mixed salts up to the molten salt regime. This model needs two parameters which can be evaluated from sparse data. For LiBr/water and (Li, K, Na) NO(3)/water mixtures, it is shown that the agreement between predicted and experimental values is very good over wide temperature and concentration ranges. The deviation between these two values was found to be less than 9 percent. DOE

**N93-18539#** Syracuse Univ., NY. Dept. of Chemical Engineering and Materials Science.

**THE EFFECT OF CATALYST PREPARATION ON CATALYTIC ACTIVITY**

J. A. Schwarz 1992 14 p

(Contract DE-FG02-87ER-13650)

(DE93-003890; DOE/ER-13650/2) Avail: CASI HC A03/MF A01

Three intrinsically connected phenomena occur during adsorption/impregnation of aqueous electrolytes onto oxide carriers. They are: pH-dependent development of surface carriers on the oxide; pH-dependent aqueous speciation of catalytic precursors; surface adsorption by complexation and coordination. Modeling of these processes yields basic thermodynamic properties of the adsorbed phase, which could provide useful information of the catalytic properties of the metal, support, and reveal metal-support interactions, thus contributing to design criteria for supported-metal catalysts. The spectrum of catalytic systems that can be studied using the above approach is greatly extended when both pure and composite oxide carriers are considered. This presentation will focus on three metal/support systems, each of which provides results of both practical and fundamental importance. DOE

**N93-18697#** Technical Research Centre of Finland, Espoo. Fire Technology Lab.

**TEST METHOD FOR SELF-IGNITION OF MATERIALS**

Jouni Bjoerkman and Olavi Keski-Rahkonen Apr. 1992 44 p Sponsored by NORDTEST

(VTT-Pubs-96; ISBN-951-38-4074-2; ETN-93-93072) Copyright Avail: CASI HC A03/MF A01

A new method for measuring the self ignition temperature by heating the specimen continuously is proposed and tested. The defined mathematical conditions for optimization of heating parameters give the basis of an algorithm for computer based oven control. Experimental results were also produced that can be seen to support the validity of the algorithm. ESA

**N93-19025*#** National Aeronautics and Space Administration. Pasadena Office, CA.

**HIGH TEMPERATURE SORBENTS FOR OXYGEN Patent Application**

Pramod K. Sharma, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 16 Dec. 1992 13 p

(Contract NAS7-918)

(NASA-Case-NPO-18409-1-CU; NAS 1.71:NPO-18409-1-CU; US-Patent-Appl-SN-991003) Avail: CASI HC A03/MF A01

A sorbent capable of removing trace amounts of oxygen (ppt) from a gas stream at a high temperature above 200 C comprising a porous alumina silicate support such as zeolite containing from 1 to 10 percent by weight of ion exchanged transition metal such as copper or cobalt ions and 0.05 to 1.0 percent by weight of an activator selected from a platinum group metal such as platinum is described. The activation temperature, oxygen sorption, and reducibility are all improved by the presence of the platinum activator. NASA

**N93-19028** Connecticut Univ., Storrs.

**A STUDY OF THE STRUCTURE OF GASEOUS DETONATION WAVES USING RAYLEIGH SCATTERING Ph.D. Thesis**

Torger James Anderson 1992 126 p

Avail: Univ. Microfilms Order No. DA9300948

An experimental program has been conducted to develop a diagnostic technique for the study of oblique detonation waves in combustible gas mixtures. The need for multi-point, non-intrusive measurements led to the use of laser-based Rayleigh scattering to determine density. In the development of the technique, it was used to study normal detonation waves and to obtain two-dimensional density images surrounding the wave front. The detonations were generated in mixtures of H2, O2 and Ar with (O2)/(Ar) held at 0.21/0.79, equivalence ratios varying between 0.6 and 1.4 and initial pressures set between .272 and .578 atm. The fourth harmonic of a Nd:YAG laser provided a pulsed sheet of UV laser light which cut through the detonation wave front as it traversed the test section to generate the Rayleigh scattering. An intensified CID camera was used to acquire and image the resulting signals. Schlieren images were acquired simultaneously for comparison. Cellular structure was clearly visible in the

images and cell sizes have been correlated with detonation parameters for comparison with measurements and analyses by earlier investigators. The progression of wave front structure could be understood by observing images which were each acquired from different runs and at random times in the wave front development. Rayleigh signal ratios comparing reactant and product densities were quantified at various locations within the wave front. They were compared with calculated values based on shock theory and equilibrium analysis and were found to be in good agreement.
Dissert. Abstr.

**N93-19485#** California Univ., Berkeley. Lawrence Berkeley Lab.
**THE EFFECT OF RHENIUM, SULFUR, AND ALUMINA ON THE CONVERSION OF HYDROCARBONS OVER PLATINUM SINGLE CRYSTALS: SURFACE SCIENCE AND CATALYTIC STUDIES Ph.D. Thesis**
C. Kim Apr. 1992 138 p
(Contract DE-AC03-76SF-00098)
(DE93-002557; LBL-32853) Avail: CASI HC A07/MF A02

Conversion reactions of hydrocarbons over Pt-Re model catalyst surfaces modified by sulfur and alumina were studied. A plasma deposition source was developed to deposit Pt, Re, and Al on metal substrates with variable coverage in ultrahigh vacuum without excessive heating. Conversion of n-hexane was performed over the Re-covered Pt and Pt-covered Re surfaces. The presence of the second metal increased hydrogenolysis activity of both Pt-Re surfaces. Addition of sulfur on the model Catalyst surfaces suppressed hydrogenolysis activity and increased the cyclization rate of n-hexane to methylcyclopentane over Pt-Re surfaces. Sulfiding also increased the dehydrogenation rate of cyclohexane to benzene over Pt-Re surfaces. It has been proposed that the Pt-Re bimetallic catalysts show unique properties when combined with sulfur, and electronic interactions exist between platinum, rhenium, and sulfur. Decomposition of hydrocarbons on the sulfur-covered Pt-Re surfaces supported that argument. For the conversion of 1-butene over the planar Pt/AlO(X), the addition of Pt increased the selectivity of hydrogenation over isomerization. DOE

**N93-19491#** Northwestern Univ., Evanston, IL.
**CHEMICAL INTERACTIONS IN MULTIMETAL/ZEOLITE CATALYSTS**
W. M. H. Sachtler 21 Dec. 1992 18 p
(Contract DE-FG02-87ER-13654)
(DE93-005133; DOE/ER-13654/6) Avail: CASI HC A03/MF A01

Research is proposed on two groups of zeolite based catalysts that contain two transition elements. In one group both metals are fully reduced, in the other group one element is left as a positive ion; it can act as a 'chemical anchor', or as a catalyst promoter for the reduced metal. The objective is to explore the potential of such materials for designing superior catalysts for synthesis and conversion of hydrocarbons and other energy carriers. ENDOR, EXAFS, CO-FTIR, and TPD will be used to identify the interaction of Mn(2+) ions with Rh(n) particles in the same zeolite cage. EXAFS at the K edge of Fe and Pd, FTIR and Moessbauer spectroscopy will be used to characterize Fe ions and alloyed Fe atoms in PdFe/NaHY. The catalysts will be probed with CO hydrogenation and conversion of hydrocarbons. Methods Which proved successful in our study of Y supported bimetal systems will be applied to identify the state of Pt and Cu in ZSM-5, a catalyst system holding large promise for NO abatement, even in the presence of oxygen. DOE

**N93-19517#** Purdue Univ., West Lafayette, IN. Dept. of Chemistry.
**PRECONVERSION CATALYTIC DEOXYGENATION OF PHENOLIC FUNCTIONAL GROUPS**
C. P. Kubiak 1992 8 p
(Contract DE-FG22-89PC-89770)
(DE93-002941; DOE/PC-89770/T13) Avail: CASI HC A02/MF A01

Aryl carbon-oxygen bond cleavage is a chemical transformation of importance in coal liquefaction and the upgrading of coal liquids as well as in the synthesis of natural products. There have been numerous attempts to discover general methods for the cleavage of aryl carbon-oxygen bonds. All the stoichiometric organic methods for phenol deoxygenation have limited applications and involve expensive reagents. Catalytic method, for the hydrodeoxygenation (HDO) of phenols involve supported transition metal oxides, such as Mo/gamma - Al2O3, Ni-MO/gamma - Al2O3, Co-Mo/gamma - Al2O3, and Fe2O3/SiO2. Typical phenol hydrodeoxygenation conditions involve hydrogen pressures in excess of 100 atm and temperatures in excess of 200 C. Under these conditions arene ring hydrogenation is generally found to compete with phenol deoxygenation; and the coproduct water is found to impair the activity of the catalysts. This proposed research offers the possibility of effecting the selective catalytic deoxygenation of phenolic functional groups using CO. The deoxygenation of phenols by carbon monoxide mediated by Ir(triphos)OAr has provided us with a catalytic Phenol deoxygenation pathway, through the elimination of CO2 and formation of a benzyne intermediate. Although the (Pt(triphos)(O-Ph-Me))PF6 system is not expected to be as efficient a catalyst as some of the other transition metals systems we are currently exploring, it will provide more information about the deoxygenation mechanism in these triphos complexes. This is due to the presence of the structurally sensitive P-31 - Pt-195 coupling constant and comparisons to the extensively studied Pt(dppe)(O-Ph)2 systems. DOE

**N93-19620#** Morgantown Technology Center, WV.
**PARTICLE COLLECTION EFFICIENCY OF A CYCLONIC COMBUSTOR**
C. E. Romero (Oak Ridge Associated Universities, Inc., TN.), D. W. Shaw (Geneva Coll., Beaver Falls, PA.), and J. S. Ontko 1992 14 p Presented at the US Department of Energy Contractors Review Meeting on Coal-Fueled Heat Engines, Advanced PFBC and Gas Stream Cleanup Systems, Morgantown, WV, 27-28 Oct. 1992
(DE93-003198; DOE/METC-C/93/7045; CONF-921034-4) Avail: CASI HC A03/MF A01

As a preliminary design study for the Combined Combustion and Cleanup Concept (4-C) Combustor, particulate capture performance was assessed by means of cold flow model testing. The goals of this effort were to: determine the relevant parameters for particle retention (also known as grade efficiency); develop a scaling law to extrapolate cold flow data to combustion conditions; obtain experimental data to develop a workable grade efficiency correlation; assess the adequacy of the correlation. The 4-C Combustor, is an effort to combine high combustion efficiency with enhanced environmental performance in a pressurized combustor for direct coal-fired gas turbine applications. The fuel is burned in an outer annular region, in a zone bounded by the outer radius of the annulus and the radius of the collection cone where it is held in suspension by a balance of centrifugal forces on the fuel particles and drag induced by secondary combustion air. After burning, the ash particles cross into a central cyclonic section, where they are removed from the gas stream and collected in a hopper at the bottom of the conical section. The cleaned gas exits the combustor through a vertical tube. DOE

**N93-19624#** Sandia National Labs., Albuquerque, NM.
**HEAVY ION BACKSCATTERING SPECTROMETRY FOR HIGH SENSITIVITY**
J. A. Knapp 1992 7 p Presented at the 12th International Conference on the Application of Accelerators in Research and Industry, Denton, TX, 2-5 Nov. 1992
(Contract DE-AC04-76DP-00789)
(DE93-002489; SAND-92-1594C; CONF-921116-8) Avail: CASI HC A02/MF A01

Heavy Ion Backscattering Spectrometry (HIBS) using moderate energy (a few hundred keV) heavy ions has demonstrated sensitivity for medium-to-heavy surface impurities on Si more than 1000 x greater than conventional Rutherford Backscattering Spectrometry (RBS). Problems with pileup are eliminated by a thin, self-supporting foil in front of the surface barrier detector (SBD), ranging out ions scattered from the substrate and allowing only ions scattered from impurities heavier than the substrate to reach the detector. Limitations to a SBD approach arise from relatively poor resolution at low energies, leading to the inability to resolve closely spaced impurity masses (such as Fe and Cu), as well as necessitating an analysis beam of 200 key or higher. In order to bypass these limitations and explore means of increasing sensitivity and mass resolution, we have built a Time-of-Flight (TOF) HIBS prototype, optimized for large solid angle. DOE

**N93-19752#** Westinghouse Environmental Management Co. of Ohio, Cincinnati. Fernald Environmental Management Project.
**PROPOSED LOWER LIMITS OF DETECTION (LLD), DECISION LIMITS (LC), AND ERROR TERMS FOR IDENTIFIED ANALYTES FROM THE INORGANIC, ISOTOPIC, BIOASSAY, AND ORGANIC GROUPS**

J. M. Jobe Jul. 1992 52 p
(Contract DE-AC05-86OR-21600)
(DE93-002942; FEMP/Sub-054) Avail: CASI HC A04/MF A01

Expressions are presented for these terms for pollutants in environmental samples, using Currie's definitions as a basis. The isotopic section covers alpha and gamma spectroscopy, alpha-beta proportional counting, mass spectrometry, x fluorescence (U, Th). The inorganic section covers trace metals, grease/oil, flash point, U-BrPADAP, Th, NO3-N, NH3-H, F, total suspended solids, U-volumetric, free liquids, percent moisture or solid. The bioassay section covers fluorometric fusion, laser phosphorescence, total particulate, gross alpha/beta, Ra226/Ra228, asbestos fiber, and bulk. The organic section covers only herbicides at this time. DOE

**N93-19854#** North Carolina Univ., Chapel Hill. Dept. of Chemistry.
**ELECTRICAL, MAGNETIC AND, SPECTROSCOPIC PROPERTIES OF (TTF)5Fe(NO3)3**
Young I. Kim and William E. Hatfield 15 Dec. 1992 14 p
(Contract N00014-92-J-1637)
(AD-A259378; TR-46) Avail: CASI HC A03/MF A01

Tetrathiafulvalene, TTF, reacts with Fe(NO3) (dot) 9H2O to yield a dark purple charge-transfer compound with the formula (TTF)5Fe(NO3)3. The effective magnetic moment at room temperature of 0.6 B. M., the temperature independent paramagnetism in the range 77-300 K, and the absence of an EPR signal attributable to iron, indicates low-spin iron(II), with electron transfer from TTF. The g values of the parallel and perpendicular EPR lines, (T, g(parallel), g(perpendicular)), (300 K, 2.007, 2.010), (77K, 2.009, 2.013), and the line widths indicate that the odd electron resides on, and is delocalized over several TTFs. The conductivity at room temperature is 17 S/cm, and the temperature dependence of the resistivity indicates semiconducting behavior of a complex nature. GRA

**N93-19894#** California Univ., Berkeley. Lawrence Berkeley Lab.
**THE EFFECTS OF GRAVITY ON WRINKLED LAMINAR FLAMES**
L. W. Kostiuk, L. Zhou, and R. K. Cheng Sep. 1992 13 p Presented at the 1992 Combustion Institute Fall Meeting of the Western States Section, Berkeley, CA, 12-13 Oct. 1992
(Contract DE-AC03-76SF-00098)
(DE93-002572; LBL-32927; CONF-9210213-1) Avail: CASI HC A03/MF A01

Laminar and turbulent conical Bunsen type flames were used. The study compares results from normal gravity with the burner in an up-right orientation (+g), the burner inverted (-g), and in microgravity (micro g) by using the NASA Lewis drop tower facility. The primary diagnostic is a laser schlieren system and some LDA measurements were taken for the +g condition to measure the flow field. The +g laminar flame experiences a large amount of instabilities and results in an unsteady flame tip; cause is torroidal vortex rolling up between products and stagnate surrounding air. Comparison between LDA measurements in reactants and schlieren images shows that velocity fluctuation are induced at the same frequency as the roll up vortices are formed. This pumping of the reactant stream by the product/air interface instability in the +g case is also observed in the turbulent flames. In the -g arrangement the product/air interface is stable so there is no large pumping of the flame tip. At low flow rates the -g flames have flattened tips, but at higher flow rates they become conical in shape. When both flames appear conical, the -g flames are longer for the same flow rate. In micro g the larger instabilities in the flame no longer exist as the product/air interface is believed to become stable. The laminar flames in micro g still show small instabilities over the entire flame. DOE

**N93-18466#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**INFRARED PHOTOLUMINESCENCE SPECTROSCOPY**
P. A. Dafesh, R. P. Wright, and C. J. Selvey *In its* Aerospace Sponsored Research 1 Dec. 1991 p 24-26 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18477#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**RADIATION PROPERTIES OF HIGH-TEMPERATURE FLAMES**
A. T. Pritt, Jr. *In its* Aerospace Sponsored Research 1 Dec. 1991 p 63-65 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18480#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
**FLOW VISUALIZATION AND COMBUSTION DIAGNOSTIC**
E. J. Beiting *In its* Aerospace Sponsored Research 1 Dec. 1991 p 70-73 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18481#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
**FLAME-FRONT KINETICS**
T. A. Spiglanin, E. W. Fournier, J. A. Syage, and R. B. Cohen *In its* Aerospace Sponsored Research 1 Dec. 1991 p 73-76 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18484#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**KINETICS AND INFRARED SPECTROSCOPY OF ORGANOMETALLIC REACTIVE INTERMEDIATES**
B. H. Weiller *In its* Aerospace Sponsored Research 1 Dec. 1991 p 82-86 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

## 26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

**N93-17852#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).
**THE BETA-CEZ, A NEW HIGH PERFORMANCE TITANIUM ALLOY FOR AEROSPACE ENGINES**
B. Champin, B. Prandi, P. E. Mosser, and Y. Honnorat 1991 22 p In FRENCH Presented at AAAF 39th Salon International de Paris on 'Materiaux pour l'Aeronautique', Le Bourget, France, 14-23 Jun. 1991
(DS-2022; ETN-93-93392) Avail: CASI HC A03/MF A01

The different steps in the development of beta-CEZ alloy are described: chemistry optimization and melting; behavior during deformation and forging; microstructure evolution during thermomechanical treatments and adjustment of the compromise between hardness and toughness; mechanical characterization of a forged roller (tensile tests, creep properties, toughness measurements, low cycle fatigue, crack propagation rate). It is concluded that the forging microstructure of rollers is slightly less ductile than that of optimized bars. Modification of heat treatment has been required leading to lower values of strength (mainly at room temperature). However compared to Ti17, (alloy of the same category), the beta-CEZ grade exhibits at least as good characteristics, with improvement in tensile creep and fatigue resistance. ESA

**N93-18007#** Army Materials Technology Lab., Watertown, MA.
**EVALUATION OF 8090 AND WELDALITE-049 ALUMINUM-LITHIUM ALLOYS**
Thomas M. Holmes, Ernest S. Chin, Paul J. Huang, and Robert E. Pasternak Sep. 1992 38 p
(AD-A258121; MTL-TR-92-59) Avail: CASI HC A03/MF A01

Aluminum-lithium (Al-Li) alloys with their high strength, high stiffness, and low density continue to be of great interest to the aerospace industry. The microstructure, properties, and fracture of 8090-T8771 and Weldalite (TM) 049-T8 Al-Li alloys were studied at MTL in participation with a cooperative round robin sponsored by the Air Force Advanced Aluminum Alloy Test Program. Both 8090 and Weldalite Al-Li alloys demonstrate superior strength to weight ratios compared to the 2519 and 5083 aluminum armor alloys. The 8090 alloy possesses comparable mechanical and ballistic properties to 2519, while providing an 8 percent reduction in density. The Weldalite has a comparable density to 2519 but demonstrates improvements of over 25 percent in yield strength, ultimate tensile strength, and fracture toughness. Both Al-Li alloys display significantly improved axial fatigue properties over 2519. Under static loading, both materials display mixed

modes of transgranular shear, microductility, and intersubgranular failure. Under ballistic testing, both alloys display mixed modes of dynamic failure by plugging, spalling, and delamination. Whether the goal is to reduce weight or to improve strength, Al-Li alloys offer significant potential for replacing alloys such as 2519 and 5083 as lightweight, high-strength, structural armor materials. GRA

**N93-18069*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**A STATISTICAL ANALYSIS OF ELEVATED TEMPERATURE GRAVIMETRIC CYCLIC OXIDATION DATA OF 36 Ni- AND Co-BASE SUPERALLOYS BASED ON AN OXIDATION ATTACK PARAMETER**

Charles A. Barrett Dec. 1992 49 p

(RTOP 505-63-5A)

(NASA-TM-105934; E-6372; NAS 1.15:105934) Avail: CASI HC A03/MF A01

A large body of high temperature cyclic oxidation data generated from tests at NASA Lewis Research Center involving gravimetric/time values for 36 Ni- and Co-base superalloys was reduced to a single attack parameter, K(sub a), for each run. This K(sub a) value was used to rank the cyclic oxidation resistance of each alloy at 1000, 1100, and 1150 C. These K(sub a) values were also used to derive an estimating equation using multiple linear regression involving log(sub 10)K(sub a) as a function of alloy chemistry and test temperature. This estimating equation has a high degree of fit and could be used to predict cyclic oxidation behavior for similar alloys and to design an optimum high strength Ni-base superalloy with maximum high temperature cyclic oxidation resistance. The critical alloy elements found to be beneficial were Al, Cr, and Ta. Author

**N93-18147#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry (France). Materials and Processes Dept.

**CHARACTERIZATION OF ALLOY 718 MICROSTRUCTURES**

Chantal Peyroutou and Yves Honnorat 1991 16 p Presented at Symposium on Superalloys 718, 625 and Various Derivatives, Pittsburgh, PA, Jun. 1991

(DS-1935; ETN-93-93373) Avail: CASI HC A03/MF A01

Current standard methods for accuracy of microstructural characterizations and particularly grain sizing are discussed and improved procedures are proposed. The use of image analysis as grain sizing technique is of a great interest as it increases speed and accuracy and also provides individual morphological parameters which can be at the origin of standard documents improvement. Several examples of computerized classifications are presented. ESA

**N93-18150#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry (France).

**SEGREGATION OF DEFECTS IN WROUGHT ALLOY 718: MANAGEMENT OF INDUSTRIAL SAFEGUARDS**

S. Bourguignon, P. Martin (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Gennevilliers, France ), and Y. Honnorat 1991 11 p Presented at TMS Minerals, Metals Materials Conference, Pittsburgh, PA, 24-26 Jun. 1991

(DS-2038; ETN-93-93390) Avail: CASI HC A03/MF A01

The fundamental melting process obstacles of alloy 718, which is widely used to manufacture aeronautical turbines, are explained. The melting of nickel base alloys is outlined and the most commonly observed defects (white spots, freckles, tree rings) are described. Since these defects reduce the tensile strength of the alloys their detection and elimination is essential. The different methods of inspection are described: macrographic inspection, ultrasonic inspection, and correlation between each indication and shift of the chemical composition. The fundamental principles of Vacuum Arc Remelting (VER) processes are outlined and the effects of white spots on the tensile strength and fatigue of the alloy are considered. ESA

**N93-18176#** Naval Postgraduate School, Monterey, CA.

**CONTINUOUS MEASUREMENT BY EDDY CURRENT METHODS OF AGE HARDENING IN AN ALUMINUM ALLOY M.S. Thesis**

John G. Esarey Sep. 1992 47 p

(AD-A257569) Avail: CASI HC A03/MF A01

Many materials processing operations such as age hardening heat treatments typically involve following predetermined time and temperature schedules to obtain the desired final material properties. The intelligent processing approach is to develop sensors for monitoring of material response to processing operations in real time. As an alloy age hardens its electrical resistivity changes. Hence, the process of aging can be monitored by measuring the change in resistivity relative to that of a non-age hardening material such as fully annealed pure aluminum. A device using two small, spiral-wound probes was designed and used to induce eddy currents within the pure aluminum and the aging alloy. The probes were incorporated as elements in an impedance bridge circuit. The bridge unbalance voltage decreased in value over time indicating decreasing resistivity during the aging process. The monitoring concept was verified. Refinements such as improved impedance bridge circuitry and probe size/test frequency optimization are needed to unlock its full potential. GRA

**N93-18182#** Naval Postgraduate School, Monterey, CA.

**MICROSTRUCTURE AND MECHANICAL PROPERTIES OF HIGH COPPER HSLA-100 STEEL IN 2-INCH PLATE FORM M.S. Thesis**

Akira Suka Jun. 1992 63 p

(AD-A257582) Avail: CASI HC A04/MF A01

The microstructure and mechanical properties of highly weldable high copper HSLA-100 steel in two-inch (50 mm) plate form were investigated in this work. The mechanical property data showed that the steel in the as-quenched and aged conditions not only met the mechanical property specifications of the Navy for HSLA (HY)-100 steels but also satisfied the requirements for HY-130 steels. Optical, scanning, and transmission electron microscope studies of the as-quenched plate indicated that the microstructure was a mixture of lath martensite/retained austenite and bainitic ferrite, which is typical of these steels. On aging, this microstructure developed the tempered structures usually encountered in HSLA steels. Increased copper HSLA steel meets all the mechanical property specifications of Navy HSLA-100 ksi yield strength steel regardless of heat treatment and plate thickness (up to 50 mm thickness). High copper HSLA-100 steel in 50 mm plate form can fulfill all the mechanical property requirements of Navy 130 ksi yield strength steel with an appropriate temper. The microstructures formed with various heat treatments are consistent with the HSLA-100 CCT diagram. Increasing copper in HSLA-100 steel also increases the toughness as well as the strength, though the dynamics of this process are not clear. GRA

**N93-18192#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

**DISLOCATION CORES STRUCTURE AND ANTIPHASE ENERGIES IN DO22 INTERMETALLICS ALLOYS VERSUS TEMPERATURE Ph.D. Thesis - Paris VI Univ. [EFFET DE LA TEMPERATURE SUR LA STRUCTURE DE COEUR DES DISLOCATIONS DANS LES INTERMETALLIQUES DO22: ASPECTS EXPERIMENTAUX ET THEORIQUES]**

Armelle Francois 1992 193 p In FRENCH

(ONERA-NT-1992-5; ETN-93-93048) Avail: CASI HC A09/MF A03

Crystal defects were investigated on Al3Ti and Ni3V alloys. Al3Ti melts are ordered; its unit cell is a tetragonal and it is very brittle. Ni3V undergoes a first order-disorder transition with its cell close to cubic and good ductility in compression. A microstructural study was conducted by transmission electron microscope under weak beam imaging conditions. In both compounds, the defect structures are characterized by the presence of microtwins and of dissociated superdislocations. In Al3Ti, dislocations show some climb activity at moderate and low temperature. An important crystal relaxation was found to occur at antiphase boundaries located on the cube and the octahedral planes. As to Al3Ti alloy, a strong elastic relaxation of the antiphase boundaries on the cube plane was observed, such that the crystal, locally, tends toward cube symmetry. In Ni3V, the equilibrium antiphase energies decrease strongly as deformation temperature increases. Theoretical calculation provides the same dependence of the antiphase boundaries energy upon temperature. It is concluded that this decrease of the antiphase boundary energy is due to chemical relaxation. ESA

**N93-18299#** Army Materials Technology Lab., Watertown, MA.

**THE EFFECTS OF CO-MINGLING DISSIMILAR FASTENER COATINGS ON THE CORROSION BEHAVIOR OF STEEL BOLT ASSEMBLIES Final Report**

Milton Levy, Brian Placzankis, Richard Brown, Robert Huie, and Michael Kane Jul. 1992 164 p
(AD-A258217; MTL-TR-92-40) Avail: CASI HC A08/MF A02

Accelerated corrosion tests were carried out to assess the performance of selected coated fastener assemblies representative of those used in the MIAI tank and Bradley fighting vehicle (coated grade 8 steel bolts fastened to armor steel and Al 5083 blocks). The coatings tested included the currently used electroplated cadmium and zinc as well as proposed electroplates of Zn-Ni, Zn-Co, Sn-Zn and a zinc phosphate modified polyacrylic acid conversion coating. The effect of co-mingling cadmium with the other coatings in the various assemblies was determined. Salt spray testing was performed in accordance with ASTM B117. In addition salt water immersion tests were performed and continuously monitored by electrochemical potential measurements. Breakaway torque values obtained after completion of either immersion or salt spray tests were correlated with coefficient of friction measurements. Cadmium electroplate exhibited the best corrosion protection for grade 8 steel bolts in salt spray or immersion tests. The zinc-nickel coating was the best overall alternative to cadmium plate. The modified zinc phosphate conversion coating was clearly unacceptable. Co-mingling of cadmium with the other coatings did not create a galvanic corrosion problem. Loosening of the Zn and Zn alloy coated fasteners will not likely occur when Cd torque values are used.
GRA

**N93-18308#** Naval Postgraduate School, Monterey, CA.
**THERMOMECHANICAL PROCESSING OF ALUMINUM ALLOY 2519 FOR GRAIN REFINEMENT AND SUPERPLASTICITY M.S. Thesis**
Scott D. Bohman 18 Jun. 1992 89 p
(AD-A257859) Avail: CASI HC A05/MF A01

Thermomechanical processing (TMP) methods developed for Al-Mg and Al-Mg-Li alloys have been modified and applied to the commercial 2519 Al-Cu alloy. The TMP included initial overaging and was designed to facilitate particle-stimulated nucleation (PSN) of recrystallization during controlled reheating intervals between successive rolling passes of the process. Effects of TMP variables were evaluated by tensile testing at temperatures ranging from 300-450 C. Strain rates varied from 6.7(10)(exp -5) s(exp -1) to 6.7(10)(exp -3) s(exp -1). Also, microstructural analysis was conducted to determine the effect of the processing on the microstructure. The further evolution of microstructure during superplastic testing of the material was also assessed. Refinement to grain sizes below 10 microns by PSN was achieved. Superplastic ductility of 260 percent elongation was limited by grain growth.
GRA

**N93-18390#** California Univ., Berkeley. Lawrence Berkeley Lab.
**A FIRST-PRINCIPLES STUDY OF THE PHASE STABILITY OF FCC-BASED Ti-Al ALLOYS**
M. Asta and D. deFontaine Apr. 1992 9 p Presented at the 1992 Material Research Society (MRS) Spring Meeting, San Francisco, CA, 27 Apr. - 2 May 1992
(Contract DE-AC03-76SF-00098)
(DE93-002549; LBL-32830; CONF-920402-62) Avail: CASI HC A02/MF A01

In this paper we present results of a first-principles phase stability study of fcc-based Ti-Al alloys. In particular the full-potential linear muffin tin orbital method has been used to determine heats of format on and other zero-temperature properties of 9 fcc ordered superstructures as well as fcc and hcp Ti, and fcc Al. From these results a set of effective cluster interactions are determined which are used in a cluster variation method calculation of the thermodynamic properties and the composition-temperature phase diagram of fcc-based alloys.
DOE

**N93-18452#** State Univ. of New York, Stony Brook. Research Foundation.
**ATOMIC AND ELECTRONIC STRUCTURE OF METALS AND ALLOYS: CLEAN SURFACES AND CHEMISORBED MOLECULES**
1993 4 p
(Contract DE-FG02-86ER-45239)
(DE93-004371; DOE/ER-45239/8) Avail: CASI HC A01/MF A01

Ultrapure Tb was further purified and surface cleaning procedures developed for basal plane and (11(-2)0) surface of Tb. Structure of both surfaces was found to be relaxed: (0001) is contracted by 3.9 percent in the first and expanded by 1.4 percent in second interlayer spacing; (11(-2)0) is contracted by 3.3 percent in first layer and shows a change in registry. Thin films of Gd, Tb, Dy, Ho, and Er were grown on W(110) substrate in ultrahigh vacuum. Studies have been carried out on epitaxial systems involving Cu, Fe and Mn on Fe and Pt, Cu, and Pd substrates, respectively; new metastable crystalline phases have been found. Studies of possible ferromagnetism in 4d elements (Rh, Ru) and relativistic effects in electron band structure of Cu(111) have been completed and published. Plans for the following year are given.
DOE

**N93-18528#** Argonne National Lab., IL.
**POLARIZED NEUTRON REFLECTION STUDY OF THE UNIDIRECTIONAL MAGNETIC ANISOTROPY OF PERMALLOY ON Ni(0.5)Co(0.5)O**
G. P. Felcher, Y. Y. Huang, M. Carey, and A. Berkowitz Aug. 1992 12 p Presented at the Symposium on Magnetic Ultrathin Films, Multilayers, and Surfaces, Lyon, France, 7-10 Sep. 1992
(Contract W-31-109-eng-38)
(DE93-000509; ANL/CP-76028; CONF-9209227-3) Avail: CASI HC A03/MF A01

Couples of ferromagnetic permalloy/antiferromagnetic metal oxide exhibit unidirectional magnetic anisotropy along a magnetic field applied during cooling. Polarized neutron reflection has been used to check if the effect is due to a bias of the antiferromagnetic configuration in the oxide, where the layer immediately adjacent to the permalloy is polarized parallel to the easy direction of magnetization. The measurements were made on a sample consisting of permalloy/500 A Ni(0.05)Co(0.5)O. The polarized neutron reflectivities taken at the four corners of the magnetic hysteresis loop at 20K. A faint magnetic signal consistent with the unidirectional bias of the F/AF structure is also observed. This behavior is discussed in the light of the current theories.
DOE

**N93-18532#** Lawrence Livermore National Lab., CA.
**HRTEM OBSERVATIONS OF MODULATED STRUCTURES IN Ti-Pd-Cr BETA(2) ALLOYS**
A. J. Schwartz and L. E. Tanner Aug. 1992 6 p Presented at the International Conference on Martensitic Transformations, Monterey, CA, 20-24 Jul. 1992
(Contract W-7405-eng-48)
(DE93-001507; UCRL-JC-111359; CONF-920722-4) Avail: CASI HC A02/MF A01

Conventional and high-resolution transmission electron microscopy (HRTEM) and electron diffraction (ED) have been used to examine a series of Ti50Pd(50-x)Cr(x)beta(2) (B2, CsCl-type crystal structure) alloys with x between 6 and 10 at. percent in order to determine the nature of the modulated structures that develop on cooling. The ED and HRTEM results reveal that the modulation periodicity (inverse of the satellite spacing) varies from three /110/(sub B2) planes in the 6 at. percent Cr alloy to four /110/(sub B2) planes for the 10 at. percent alloy. Over the same composition range, the 'monoclinic angle' (defined between (200)(sub B2) and (020)(sub B2) reflections) is found to increase linearly from 88 to 90 degrees. It is suggested that these effects are associated with the substitution of Cr for Pd that gives rise to an electronically driven (110)(sub q)a group of zone axes (110)(sub var-epsilon) phonon anomaly.
DOE

**N93-18534#** Oak Ridge National Lab., TN.
**DUCTILITY AND FRACTURE IN L1(SUB 2) INTERMETALLIC ALLOYS**
J. A. Horton 1992 7 p Presented at the First Pacific Rim International Conference on Advanced Materials and Processing, Hangzhou, China, 23-27 Jun. 1992
(Contract DE-AC05-84OR-21400)
(DE93-001644; CONF-920621-1) Avail: CASI HC A02/MF A01

This paper provides a comprehensive review of the ductility and fracture in Ni3Al, was thought to have intrinsically brittle grain boundaries. Because of the dramatic effect boron has on the grain boundaries, much work has focused on analysis of the details of the grain boundary chemistry and structure with and without boron. We now know ductilities of up to 50 percent are possible in boron-free material, given a defect-free specimen tested in an atmosphere with as little water vapor or hydrogen as possible. Another group of L1(sub 2), alloys, such as Al3Sc and alloys based on the trialuminide Al3Ti, currently appear to be intrinsically brittle, failing by cleavage with fracture toughness values of around 2 to 3 MPa m(exp 1/2). These alloys deform by the expected slip systems, /111/ a group of

zone axes (110), that provide sufficient deformation modes that should allow ductile behavior. These alloys are generally rather soft with yield strengths as low as 200 MPa and hardnesses as low as 150 DPH, suggesting that dislocation generation and motion is fairly easy in these materials. While a low cleavage energy and a high modulus appear to be the fundamental cause for the complete lack of ductility, the possibility exits that they too are not intrinsically brittle. DOE

**N93-18535#** California Univ., Berkeley. Lawrence Berkeley Lab.
**STRUCTURAL TRANSFORMATION OF NICKEL HYDROXIDE FILMS DURING ANODIC OXIDATION**
R. W. Crocker and R. H. Muller May 1992 8 p Presented at the 182nd Meeting of the Electrochemical Society, Toronto, Ontario, 11-16 Oct. 1992
(Contract DE-AC03-76SF-00098)
(DE93-001863; LBL-32417; CONF-921036-9) Avail: CASI HC A02/MF A01

Investigation of anodically formed nickel hydroxide/oxy-hydroxide electrodes has determined that the phase boundary between the materials evolves via a nodular structure within the electrode film during the anodic oxidation reaction. This nodular growth mechanism is caused by the disparity in conductivity between the phases. Unconverted material is trapped within the film by an overlayer which forms across the film/electrolyte interface. Scanning tunneling microscopy and spectroscopic ellipsometry experiments support this structure model. DOE

**N93-18589#** Boston Univ., MA. Dept. of Chemistry.
**STUDY OF INTERMEDIATES FROM TRANSITION METAL EXCITED-STATE ELECTRON-TRANSFER REACTIONS**
M. Z. Hoffman 31 Dec. 1991 19 p
(Contract DE-FG02-86ER-13603)
(DE93-001682; DOE/ER-13603/5) Avail: CASI HC A03/MF A01

During this period, conventional and fast-kinetics techniques of photochemistry, photophysics, radiation chemistry, and electrochemistry were used for the characterization of the intermediates that are involved in transition metal excited-state electron-transfer reactions. The intermediates of interest were the excited states of Ru(II) and Cr(III) photosensitizers, their reduced forms, and the species formed in the reactions of redox quenchers and electron-transfer agents. Of particular concern was the back electron-transfer reaction between the geminate pair formed in the redox quenching of the photosensitizers and the dependence of its rate on solution medium and temperature in competition with transformation and cage escape processes. DOE

**N93-18603*#** Iowa State Univ. of Science and Technology, Ames. Inst. for Physical Research and Technology.
**MICROSTRUCTURAL DEVELOPMENT DURING DIRECTIONAL SOLIDIFICATION OF PERITECTIC ALLOYS Final Technical Report, 1 Aug. 1991 - 30 Sep. 1992**
Thomas A. Lograsso 1992 29 p
(Grant NAGw-2601)
(NASA-CR-192090; NAS 1.26:192090) Avail: CASI HC A03/MF A01

Despite the widespread commercial use of peritectic alloys (e.g., steels, brass, bronze, intermetallic compounds, Co based superalloys and A3B type superconductors), the characterization of the microstructural development during directional solidification of peritectics has historically lagged behind similar efforts directed towards other types of binary invariant reactions such as eutectic or monotectic. A wide variety of possible microstructures has been shown to form in peritectics depending upon the imposed temperature gradient, G, the solidification velocity, V, as well as the presence or absence of convection in the melt. This has important technological implications since many commercially important alloys exhibit peritectics and processing methods such as casting and welding often involve widely changing conditions. It has been the aim of this project to examine, in a systematic fashion, both experimentally and theoretically, the influence of gravitationally driven convection on segregation and microstructural development during solidification in peritectic systems under terrestrial conditions. The scientific results of the project will be used to establish ground based data in support of a meaningful microgravity flight experiment. I.I.C.

**N93-18655#** Technical Research Centre of Finland, Espoo. Metals Lab.
**CORROSION FATIGUE OF TITANIUM IN SEA WATER UNDER CATHODIC POLARIZATION**
Paivi Varis and Irina Aho-Mantila Mar. 1992 43 p Sponsored by Finnish industry and Technology Development Center of Finland
(VTT-Pubs-91; ISBN-951-38-4069-7; ETN-93-93069) Copyright Avail: CASI HC A03/MF A01

A study to examine whether titanium shows accelerated fatigue crack growth caused by hydrogen embrittlement under cathodic polarization is described. The unalloyed titatium (grade 2) and Ti-6Al-4V (grade 5) crack growth rate tests were performed in flowing ASTM (American Society for Testing and Materials) sea water at room temperature using a servohydraulic universal test machine equipped with an environment cell. The applied potentials were between -800 and -1500 mV versus Saturated Calomel Electrode (SCE). For comparison, crack growth rate tests in air for both materials were also performed. Cathodic polarization in sea water did not accelerate the crack growth in unalloyed grade 2 type titanium compared with the crack rate in air. For titanium grade 5, the applied cathodic potentials slightly accelerated the crack growth in the potential range of between -800 and -1050 mV (SCE). However, at the lowest applied potentials, -1200 and -1500 mV (SCE), the crack growth rate decreased again to even lower rates than was measured for the same material in air. No effect of hydrogen in the fracture surface morphology of the fatigued specimens was observed in the scanning electron microscopy examination. ESA

**N93-18706#** Oak Ridge National Lab., TN.
**HIGH-ENERGY MAGNETIC EXCITATIONS IN Mn(SUB 90)Cu(SUB 10)**
J. A. Fernandez-Baca, R. M. Nicklow, M. E. Hagen, and T. G. Perring 1992 13 p Presented at the Conference on Magnetism and Magnetic Materials, Houston, TX, 1-4 Dec. 1992
(Contract DE-AC05-84OR-21400)
(DE93-001634; CONF-921201-5) Avail: CASI HC A03/MF A01

The study of the magnetic excitations in Mn-rich alloys should be a good test of the multiband calculations of the spin dynamics of pure (gamma)-Mn, which is a prototypical itinerant-electron antiferromagnet. In this paper we report the results of recent neutron inelastic scattering measurements performed on Mn(sub 90)Cu(sub 10) at room temperature (T = 0.63 T(sub N)) and up to 300 meV of energy transfer. These measurements were performed using the HET chopper-spectrometer at the ISIS spallation neutron source, Rutherford Appleton Laboratory, U.K. The results have been compared with calculations using a model scattering function convoluted with the full HET resolution function. In this model there is a steep linear spin-wave dispersion (D approx. 250 meV-(Angstrom)) for wavevectors up to approx. 1/2 of the Brillouin zone and a strong damping which is linear in the wavevector q. For larger wavevectors the spin-wave energies are constant at about 190 meV. These features are qualitatively similar to the predictions of Cade and Yeung for pure (gamma)-Mn. DOE

**N93-18979#** Army Lab. Command, Watertown, MA. Material Technology Lab.
**LARGE STRAIN COMPRESSION OF TWO TUNGSTEN ALLOYS AT VARIOUS STRAIN RATES Final Report**
John L. Green and Paul Moy Sep. 1992 22 p
(AD-A258789; MTL-TR-92-66) Avail: CASI HC A03/MF A01

This report describes the material characterization of two tungsten alloys in terms of their modulus of elasticity, yield stresses, and true stress-true strain curves. These alloys are W2 (Kennametal) with 97.2 percent tungsten and X21 (Teledyne, Firth, and Sterling) with 93 percent tungsten. Both alloys were compressed to strains between 40 and 75 percent, and at strain rates between 0.0001/sec and 3000/sec. The experiments were conducted in the Medium Strain Rate Machine (MSRM) and Split Hopkinson Pressure Bar (SHPB) facilities at the U.S. Army Materials Technology Laboratory (MTL). The effect of strain rate was ascertained for each alloy and a comparison conducted on their stress-strain relationships. Metallographic examinations of the microstructure were conducted on both tungsten alloys to determine if adiabatic shear bands had developed. Zones of shear deformation were observed but were attributed to frictional effects at the ends of specimens. At large deformations, frictional effects cause specimen barrelling and a three-dimensional stress state. Annular grooves were machined into the ends of the specimens and, in addition, Teflon(TM)

sheets provided lubrication thereby eliminating frictional effects. Both alloys are strain rate sensitive; however, the W2 alloy is somewhat more sensitive at higher strain-rates. No adiabatic shear bands were observed and shear deformation due to frictional effects was eliminated by using the modified specimen and Teflon(TM) sheeting. GRA

**N93-19061** Virginia Univ., Charlottesville.
**A GEOMETRICAL DESCRIPTION OF MICROSTRUCTURE WITH APPLICATION TO Al POWDER METALLURGY PROCESSING Ph.D. Thesis**
Joseph Buford Parse 1992 118 p
Avail: Univ. Microfilms Order No. DA9237627

The spatial distribution of second-phase particles in materials, and inhomogeneities such as clusters of second-phase particles, are known to affect bulk properties of particle-containing materials. The lack of a convenient method for quantitative characterization of the spatial distribution of second-phase particles has limited understanding of the mechanisms underlying these effects. The Dirichlet tessellation, and the associated dual tessellation, provide a unique, geometrical description of the spatial distribution of second-phase particles. This dissertation describes a computerized analysis, based on the Dirichlet tessellation, for quantitative characterization of the spatial distribution of second-phase particles. The analysis was designed to operate on a PC in the interest of wide applicability. For reasons of computational simplicity, particle size and morphology are excluded from the analysis. The analysis provides statistical descriptions of several microstructural variables, including local particle density and nearest-neighbor distances. An analysis of particle clustering, based on the dual tessellation and an assumed particle interaction distance, provides a detailed description of clustering of second-phase particles. Analysis of computer-generated particle distributions provides insight into the effect of spatial inhomogeneities and plane-strain deformation on the tessellation and clustering characteristics of various types of particle distributions. The analysis method was applied to determining the effects of type and degree of deformation processing on the spatial distribution of oxide fragments in PM-Al alloy sheet. Forging with subsequent rolling, and cross-rolling, were found to produce significantly more effective fragmentation and dispersal of the oxide skin than direct-rolling, per unit effective strain. The effect of deformation on clustering characteristics of oxide fragments in direct-rolled sheet exhibits good agreement with results from simulations using computer-generated particle arrays. Dissert. Abstr.

**N93-19437#** EG and G Rocky Flats, Inc., Golden, CO.
**APPLICATION OF MOLTEN SALTS IN PYROCHEMICAL PROCESSING OF REACTIVE METALS**
B. Mishra (Colorado School of Mines, Golden.), D. L. Olson (Colorado School of Mines, Golden.), and W. A. Averill 1992 20 p Presented at The Light Metal Symposium, Denver, CO, 21-25 Feb. 1993
(Contract DE-AC34-90DP-62349)
(DE92-018618; RFP-4610; CONF-930219-1) Avail: CASI HC A03/MF A01

Various mixes of chloride and fluoride salts are used as the media for conducting pyrochemical processes in the production and purification of reactive metals. These processes generate a significant amount of contaminated waste that has to be treated for recycling or disposal. Molten calcium chloride based salt systems have been used in this work to electrolytically regenerate calcium metal from calcium oxide for the in situ reduction of reactive metal oxides. The recovery of calcium is characterized by the process efficiency to overcome back reactions in the electrowinning cell. A thermodynamic analysis, based on fundamental rate theory, has been performed to understand the process parameters controlling the metal deposition, rate, behavior of the ceramic anode-sheath and influence of the back-reactions. It has been observed that the deposition of calcium is dependent on the ionic diffusion through the sheath. It has also been evidenced that the recovered calcium is completely lost through the back-reactions in the absence of a sheath. A practical scenario has also been presented where the electrowon metal can be used in situ as a reductant to reduce another reactive metal oxide. DOE

**N93-19480#** California Univ., Berkeley. Lawrence Berkeley Lab.
**ELECTRONIC STRUCTURE OF SUBSTITUTIONALLY DISORDERED ALLOYS: DIRECT CONFIGURATIONAL AVERAGING**
C. Wolverton, D. deFontaine, H. Dreysse, and G. Ceder Apr. 1992 10 p Presented at the 1992 Material Research Society (MRS) Spring Meeting, San Francisco, CA, 27 Apr. - 2 May 1992
(Contract DE-AC03-76SF-00098)
(DE93-002548; LBL-32829; CONF-920402-65) Avail: CASI HC A02/MF A01

The method of direct configurational averaging (DCA) was proposed to study the electronic structure of disordered alloys. Local density of states and band structure energies are obtained by averaging over a small number of configurations within a tight-binding Hamiltonian. Effective cluster interactions, the driving quantities for ordering in solids, are computed for various alloys using a tight-binding form of the linearized muffin-tin orbital method (TB-LMTO). The DCA calculations are used to determine various energetic and thermodynamic quantities for binary and ternary alloys. DOE

**N93-19486#** California Univ., Berkeley. Lawrence Berkeley Lab.
**PHASE STABILITY OF FCC- AND HCP-BASED INTERMETALLICS: THE Ti-Al AND Cd-Mg SYSTEMS**
M. Asta (California Univ., Berkeley.), R. McCormack (California Univ., Berkeley.), M. vanSchilfgaarde (SRI International Corp., Menlo Park, CA.), and G. Ceder (Massachusetts Inst. of Tech., Cambridge.) Jun. 1992 7 p Presented at the NATO Advanced Study Institute on Statics and Dynamics of Alloy Phase Transformations, Rhodes, Greece, 21 Jun. - 3 Jul. 1992
(Contract DE-AC03-76SF-00098)
(DE93-002558; LBL-32831; CONF-9206202-5) Avail: CASI HC A02/MF A01

In this paper we summarize results of first-principles phase stability studies of fcc- and hcp-based Ti-Al alloys and of the hcp-based Cd-Mg system. In particular, heats of formation for ordered alloy compounds are calculated with the linear muffin tin orbital method; effective cluster interactions are determined from the results of these calculations and are used to derive thermodynamic properties and composition-temperature phase diagrams. DOE

**N93-19514#** Argonne National Lab., IL.
**STRENGTH AND RUPTURE-LIFE TRANSITIONS CAUSED BY SECONDARY CARBIDE PRECIPITATION IN HT-9 DURING HIGH-TEMPERATURE LOW-RATE MECHANICAL TESTING**
R. J. DiMelfi, E. E. Gruber, J. M. Kramer, and T. H. Hughes 1992 10 p Presented at the Fall Meeting of the Metallurgical Society and American Institute of Metallurgical and Petroleum Engineers, Chicago, IL, 1-5 Nov. 1992
(Contract W-31-109-eng-38)
(DE93-002917; ANL/RE/CP-75828; CONF-921109-3) Avail: CASI HC A02/MF A01

The martensitic-ferritic alloy HT-9 is slated for long-term use as a fuel-cladding material in the Integral Fast Reactor. Analysis of published high-temperature mechanical property data suggests that secondary carbide precipitation would occur during service life causing substantial strengthening of the as-heat-treated material. Aspects of the kinetics of this precipitation process are extracted from calculations of the back stress necessary to produce the observed strengthening effect under various creep loading conditions. The resulting Arrhenius factor is shown to agree quantitatively with shifts to higher strength of crept material in reference to the intrinsic strength of HT-9. The results of very low constant strain-rate high-temperature tensile tests on as-heat-treated HT-9 that focus on the transition in strength with precipitation will be presented and related to rupture-life. DOE

**N93-19614#** Oak Ridge Y-12 Plant, TN.
**VACUUM DEPOSITION OF COPPER ON TYPE 304L STAINLESS STEEL**
R. W. Vasofsky and W. D. Corbett, Jr. 3 Sep. 1992 19 p
(Contract DE-AC05-84OS-21400)
(DE93-002704; Y/DZ-943) Avail: CASI HC A03/MF A01

The standard procedure for electroplating a thin layer of copper on type 304L stainless steel requires several aqueous pretreatment steps. Several of these steps are associated with the generation of Resource Conservation and Recovery Act (RCRA) hazardous wastes. An investigation was conducted to determine if a more environmentally acceptable procedure can be implemented to replace the current approach. The study consisted of vacuum depositing copper onto 1-in.-square 304L coupons under different

vacuum deposition conditions and, subsequently, examining the microstructure and adhesive properties of the coating produced. The results indicated that a noncolumnar, fine-grain copper coating with high adhesion can be produced using this environmentally more acceptable approach.
DOE

**N93-19629#** Oak Ridge National Lab., TN.
**PRINCIPLES OF WELD SOLIDIFICATION AND MICROSTRUCTURES**
S. A. David and J. M. Vitek 1992 11 p Presented at the 3rd International Conference on Trends in Welding Research, Gatlinburg, TN, 1-5 Jun. 1992
(Contract DE-AC05-84OR-21400)
(DE93-003012; CONF-9206173-10) Avail: CASI HC A03/MF A01

The integrity and performance of a weld is, to a large extent, controlled by the solidification behavior of the weld metal or fusion zone (FZ). It controls weld-metal microstructure, grain structure, inclusion distribution, porosity, hot-cracking behavior, and, ultimately, weld-meted properties. Weld metal solidification can be understood in the light of recent advances made in solidification theories that relate to castings and rapid solidification of materials. This paper summarizes some of the recent progress made in understanding the weld-pool solidification behavior and its influence on weld-metal microstructures.
DOE

**N93-19631#** Oak Ridge National Lab., TN.
**X RAY EXAMINATION OF TYPE 310S STAINLESS STEEL DURING ITS OXIDATION IN AIR AT 900 C**
O. B. Cavin and J. S. Wolf (Clemson Univ., SC.) 1992 17 p Presented at the Annual Denver X Ray Conference, Denver, CO, 3-7 Aug. 1992
(Contract DE-AC05-84OR-21400)
(DE93-003031; CONF-9208129-9) Avail: CASI HC A03/MF A01

Type 310S stainless steel was exposed in air at 900 C and simultaneously examined periodically by X-ray diffraction in an attempt to determine the structural evolution of the compounds formed on its surface. The adherent oxide product was found to be a two-layered scale composed of an inner sesquioxide and an outer spinel layer. Both of these compounds exhibited systematic changes in their unit cell sizes as a function of increasing exposure time at constant temperature. The spinel showed an increase in its lattice parameter while the sesquioxide and stainless steel substrate both had decreases in their parameters proportional to the square root of exposure time. In each of the three phases, the rate of change was constant up to approximately four hours after which the parameters approached a limiting value. Evidence also exists for the presence of at least localized stresses in the scales.
DOE

**N93-19635#** Oregon Graduate Inst. of Science and Technology, Beaverton.
**DEFORMATION INDUCED MICROSTRUCTURAL AND MICROCHEMICAL CHANGES DURING THERMOMECHANICAL TREATMENT**
D. G. Atteridge, W. E. Wood, and S. M. Bruemmer (Pacific Northwest Lab., Washington, DC.) 1992 75 p
(Contract DE-AC06-86NE-37963)
(DE93-005060; DOE/NE-37963/22) Avail: CASI HC A04/MF A01

An analytical model has been developed for predicting thermomechanical effects on the development of grain boundary chromium depletion in austenitic stainless steel as a first step in predicting intergranular stress corrosion cracking susceptibility. Model development and validation is based on sensitization development analysis of over 30 Type 316 and 304 stainless steel heats. The data base included analysis of deformation effects on resultant sensitization development. Continuous cooling sensitization behavior is examined and modeled with and without strain. Gas tungsten arc girth pipe weldments are also characterized by experimental measurements of heat affected zone temperatures, strains and sensitization during/after each pass; pass by pass thermal histories are also predicted. The model is then used to assess pipe chemistry changes on chromium depletion changes.
DOE

**N93-18485#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
**MICROSTRUCTURAL CONTROL OF COMPLEX ALLOYS**
C. C. Wan *In its* Aerospace Sponsored Research 1 Dec. 1991 p 86-90 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18488#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
**EXPERIMENTAL AND THEORETICAL STUDIES OF THE STRUCTURE OF METAL DICHALCOGENIDES**
J. R. Lince and T. B. Stewart *In its* Aerospace Sponsored Research 1 Dec. 1991 p 94-96 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-19391*#** University of Central Florida, Orlando.
**USE OF CYCLIC CURRENT REVERSAL POLARIZATION VOLTAMMETRY FOR INVESTIGATING THE RELATIONSHIP BETWEEN CORROSION RESISTANCE AND HEAT-TREATMENT INDUCED VARIATIONS IN MICROSTRUCTURES OF 400 C MARTENSITIC STAINLESS STEELS**
John R. Ambrose *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 1-30 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

## 27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

**N93-17812#** Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France). Groupe Microstructures Silicium et Microsystemes Integres.
**FEASIBILITY OF SILICON NITRIDE FILMS BY VAPOR DEPOSITION AT LOW TEMPERATURE: COMPARISON OF DICHLORSILANE-AMMONIA AND DISILANE GASEOUS SYSTEMS Ph.D. Thesis - Toulouse Univ.**
Kouakou Leonce Kouassi 1992 133 p In FRENCH
(LAAS-92249; ETN-93-93363) Avail: CASI HC A07/MF A02

Research aimed at the optimization of low pressure chemical vapor deposition of polycrystalline silicon and of insulators such as silicon nitride, key processing for the improvement and innovation in the integrated circuit and microstructures based on silicon, is reported. Optimization involves the improvement of the homogeneity and of the reproducibility. A further goal was to carry out processes at very low temperature (at about 600 C) and below. The feasibility of silicon nitride films was studied using three gaseous precursors for silicon (dichlorsilane, silane and disilane) mixed with ammonia. The first precursor studied shows that at 600 C, the silicon supply (by dichlorsilane pyrolysis) limits the growth kinetic. So, an optimal growth rate of 8 to 9 A/min was obtained for films nearly stochiometric. The studies of the electrical quality yield a breakdown field of about 7 to 10 MV/cm. The studies of the deposition, in the range 555 to 600 C, from siliane ammonia mixture do not present any advantage (kinetic, homogeneity) relatively to the dichlorsilane ammonia mixture. The third silicon precursor was more specifically studied, because of the experience established in the Si films made from disilane which is nowadays produced in quantity and quality compatible with an industrial process. The operating conditions (flow rate and ratio, pressure) leading to a kinetic and a quality of deposit industrially exploitable are drawn. It was shown that high growth rate (greater than or equal 20 A/min) can only be obtained for silicon rich films. The studies of the electrical quality yield breakdown fields of about 6 to 8 MV/cm.
ESA

**N93-17866#** Army Construction Engineering Research Lab., Champaign, IL.
**EVALUATION OF TEST METHODS TO DETERMINE THE IMPACT RESISTANCE OF EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) Final Report**
Richard G. Lampo and Jonathan C. Trovillion Jul. 1992 59 p
(AD-A258433; CERL-TR-FM-92-01) Avail: CASI HC A04/MF A01

The use of exterior insulation and finish systems (EIFS) on Army facilities has increased substantially over the past 10 years. The importance of impact resistance in maintaining system integrity to prevent moisture infiltration (a leading cause of system failure) is paramount. Army architect/engineers need to know the relative impact resistance of systems so they can specify the correct system for a given use at the lowest cost.

Industry-wide standard impact test methods are not available; values reported by EIFS manufacturers cannot be compared throughout the industry. The objective of this study was to evaluate test methods for impact resistance currently being used in industry and determine their validity for use with EIFS on Army facilities. Researchers tested 23 EIFS using the two most common laboratory impact test methods and one field test method. Researchers compared the test results with performance assumptions based on the systems' chemical and physical properties to conclude that the falling ball test is the best of the methods evaluated for assessing the overall impact resistance of EIFS. The results of this research were used to develop a draft standard test method that was presented to the American Society of Testing and Materials. GRA

**N93-17899#** Montpellier-2 Univ. (France)
**SONOGELS IN THE PREPARATION OF ADVANCED GLASS AND CERAMIC MATERIALS Final Report, 1 Sep. 1989 - 31 Aug. 1992**
J. Zarzycki 20 Oct. 1992 117 p
(Grant AF-AFOSR-0533-89)
(AD-A258184; AFOSR-92-0981TR) Avail: CASI HC A06/MF A02

Ultrasonic irradiation of mixtures of alkoxides and water (the sonocatalytic method) was shown to provide an interesting way of preparing matrices for ceramic-ceramic composites. The gelation speed of the sonogels can be sufficiently controlled to avoid the segregation of short Al2O3 or ZrO2 fibres used as fillers. High homogeneity dispersions were produced in this way and the density of samples increased. In the case of cordierite, 5 SiO2, Al2O3, 2MgO matrices the strength of the composite strongly depends on the type of crystallographic phase, micro-cordierite which is converted into alpha-cordierite by a thermal treatment. Hot-pressing proved necessary, however, to obtain samples with sufficient mechanical strength. A substantial increase in the resistance was obtained by the addition of optimal quantity of TiO2 nucleant in precursor form to the starting cordierite sonosol. This method enables the hot-pressing to be performed while the matrix is in a glassy form, which improves the compaction by viscous flow. A subsequent thermal treatment is used to convert the seeded glass matrix into fine-grain glass-ceramic. The mechanical strength depended on the volume fraction of the filler phase (fibers). The best results obtained were: 105 MPa for cordierite-ZrO2 fibers and 158 MPa for cordierite-Al2O3 fiber composites. GRA

**N93-17906#** Army Lab. Command, Watertown, MA. Material Technology Lab.
**REVERSION STUDIES OF NATURAL AND GUAYULE RUBBERS Final Report**
James M. Sloan Aug. 1992 12 p
(AD-A257501; MTL-TR-92-53) Avail: CASI HC A03/MF A01

The curing and reversion (loss of mechanical properties) characteristics of sulfur-cured guayule rubber were compared with that of natural rubber. A series of formulated natural and guayule rubber compounds was studied by employing Fourier transform infrared spectroscopy and mechanical spectroscopy to characterize the cure and reversion behavior. The reversion process was found to be dependent on the amount of trans-methine structure formed during and after vulcanization. The appearance of this molecular species coincided with the onset of mechanical reversion. Two variables affecting the cure and reversion process were studied: the amount of carbon black loading and the temperature of cure. It has been observed that reversion and G'(max) are significantly affected by carbon black loading. An increase in carbon black loading showed a decrease in reversion and an increase in G'(max). As the cure temperature was increased, an increase in reversion was detected. In general, guayule rubber exhibited a slower rate of reversion than natural rubber; however, natural rubber exhibited a larger modulus than guayule rubber. GRA

**N93-17909#** Sandia National Labs., Albuquerque, NM.
**THERMAL COATING DEVELOPMENT FOR IMPULSE DRYING**
William J. Lenling (Thermal Spray Technologies, Watertown, WI.), Mark F. Smith, and David I. Orloff (Institute of Paper Science and Technology, Atlanta, GA.) 1992 6 p Presented at the 1992 International Thermal Spray Conference, Orlando, FL, 1-5 Jun. 1992
(Contracts DE-AC04-76DP-00789; DE-FG02-85CE-40738)
(DE93-000710; SAND-92-1290C; CONF-9206135-6) Avail: CASI HC A02/MF A01

A plasma sprayed coating has been developed for the heated surface of rolls used in a new energy-efficient paper drying process, known as impulse drying, which could save the US paper industry an estimated $800 million annually in reduced energy costs. Because impulse drying rolls operate at higher surface temperatures than conventional, the thermal properties of the roll surface must be carefully tailored to prevent sheet delamination. A special plasma sprayed thermal barrier coating has been developed to control thermal mass, heat transfer, and steam infiltration. A coated test platen significantly outperformed a comparable uncoated steel platen in preliminary experiments with a heavy-weight paper grade on a laboratory-scale impulse drying simulator. The coating was then tested on the roll of a pilot-scale impulse dryer. In comparison with conventional wet-pressing, linerboard that was impulse dried showed improved water removal as well as improved physical properties, such as density and specific elastic modulus. The successful prototype coating design has three plasma sprayed layers that are deposited sequentially: (1) a nickel alloy bond coat; (2) a thick 17 percent porous, zirconia thermal barrier; and (3) a thin, 5-7 percent porous, zirconia top coat. DOE

**N93-17945*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**POSITRON LIFETIME SPECTROSCOPY FOR INVESTIGATION OF THIN POLYMER COATINGS**
Jag J. Singh, Danny R. Sprinkle, and Abe Eftekhari (Hampton Univ., VA.) Washington Feb. 1993 7 p
(RTOP 141-20-06-10)
(NASA-TM-4421; L-17165; NAS 1.15:4421) Avail: CASI HC A02/MF A01

In the aerospace industry, applications for polymer coatings are increasing. They are now used for thermal control on aerospace structures and for protective insulating layers on optical and microelectronic components. However, the effectiveness of polymer coatings depends strongly on their microstructure and adhesion to the substrates. Currently, no technique exists to adequately monitor the quality of these coatings. We have adapted positron lifetime spectroscopy to investigate the quality of thin coatings. Results of measurements on thin (25-micron) polyurethane coatings on aluminum and steel substrates have been compared with measurements on thicker (0.2-cm) self-standing polyurethane discs. In all cases, we find positron lifetime groups centered around 560 psec, which corresponds to the presence of 0.9-A(exp 3) free-volume cells. However, the number of these free-volume cells in thin coatings is larger than in thick discs. This suggests that some of these cells may be located in the interfacial regions between the coatings and the substrates. These results and their structural implications are discussed in this report. Author

**N93-17949#** Technische Univ., Darmstadt (Germany). Fachbereich Physik.
**MESOPHASE FORMATION BY SPECIFIC INTERACTIONS IN LOW MOLECULAR AND POLYMER SYSTEMS Ph.D. Thesis [MESOPHASENFORMATION DURCH SPEZIFISCHE WECHSELWIRKUNGEN IN NIEDERMOLEKULAREN UND POLYMEREN SYSTEMEN]**
Martina Ebert 1990 128 p In GERMAN
(ETN-93-93311) Avail: CASI HC A07/MF A02

The influence of specific interactions of various types in the formation of anisotropic liquid phases was examined in polymer systems and low molecular model systems. Strong interactions, such as hydrogen bridge bonds and Charge Transfer (CT) interactions on special synthetized systems were analyzed. Phase behavior was considered, using differential calorimetry and polarization microscopy. The structural analysis of the mesosphere was undertaken by scattered X-ray experiments. The influence of specific interactions on the structural formation of anisotropic liquid systems was systematically characterized. It is shown that the introduction of specific interactions allows the selective adjustment of phase temperature, phase width, and phase type. ESA

**N93-17966#** Northwestern Univ., Evanston, IL. Dept. of Materials Science and Engineering.
**PULSED LASER DEPOSITION OF AMORPHOUS DIAMOND-LIKE CARBON FILMS WITH ArF (193 nm) EXCIMER LASER**
F. Xiong, Y. Y. Wang, V. Leppert, and R. P. Chang Nov. 1992 30 p
(Contract N00014-89-J-1848)
(AD-A257551; TR-10) Avail: CASI HC A03/MF A01

We have deposited hydrogen-free diamond-like amorphous carbon (amorphous diamond) films by ArF (193 nm) pulsed laser ablation of graphite. The deposition process is performed with the laser power density of only 5 x l0 exp 8 W/sq cm at room temperature without any auxiliary energy source incorporation. The resulting films possess remarkable physical, optical, and mechanical properties which are close to those of diamond and distinct from the graphite target used. The films have a mechanical hardness up to 38 GPa, an optical energy band gap of 2.6 eV, and excellent thermal stability. Analysis of electron energy loss spectroscopy reveals the domination of diamond-type tetrahedral bonding structure in the films with the sp3 bond fraction over 95 percent. Compared to other reported results of pulsed laser deposited diamond-like carbon films, our experimental results confirm that the laser wavelength or photon energy plays a crucial role in controlling the properties of the pulsed laser deposited diamond-like carbon films. GRA

**N93-17967#** Northwestern Univ., Evanston, IL. Dept. of Materials Science and Engineering.

**A COMPARISON STUDY OF DIAMOND FILMS GROWN ON TUNGSTEN CARBIDE COBALT TOOLS INSERTS WITH CH4 AND CF4 GAS SOURCES**

K. J. Grannen, F. Xiong, and R. P. Chang Nov. 1992 32 p
(Contract N00014-89-J-1848)
(AD-A257552; TR-9) Avail: CASI HC A03/MF A01

The results of a comparison study of continuous diamond coatings deposited on tungsten carbide-6 percent cobalt tool inserts using CF4, and CH4, gas sources are presented. The CH4, grown diamond film utilizes a thin (1200 A) amorphous silicon interlayer for adhesion while the CF4, diamond film is deposited directly onto the tool insert. Diamond films produced with CF4 gas have much higher growth rates and better adhesion than diamond films grown with CH4 gas. The films are characterized by scanning and transmission electron microscopy, and Raman spectroscopy to determine film crystallinity and quality. Macroscopic indentation tests have been conducted to determine the adhesion of the films to the substrate, and an aluminum-17 percent Si alloy is machined with the diamond-coated tool inserts to determine their performance in a machining environment. A mechanism for the growth of diamond on tungsten carbide-cobalt using CF4 gas is postulated. GRA

**N93-18003#** Tennessee Univ., Knoxville. Dept. of Engineering Science and Mechanics.

**NON-FICKIAN MOISTURE DIFFUSION IN POLYMERIC COMPOSITES Technical Report, 1 Jan. 1990 - 31 Dec. 1992**

L. W. Cai and Y. Weitsman Sep. 1992 36 p
(Contract N00014-90-J-1556)
(AD-A257919; ESM92-6.0-MECH) Avail: CASI HC A03/MF A01

This article concerns the effects of non-Fickian water diffusion in fiber-reinforced polymeric composites. The departure from classical diffusion is attributed to the time-dependent response of the polymer, akin to viscoelastic mechanical response. A formulation is provided to evaluate the coefficient of moisture diffusion and moisture profiles within the composite for the non-Fickian case. In addition, it is demonstrated that computed magnitudes of residual hygro-thermal stresses may differ by about 25 percent from predictions based upon classical diffusion. GRA

**N93-18122#** Defence Research Agency, Malvern (England).

**CODE VECTOR DENSITY IN TOPOGRAPHIC MAPPINGS Memorandum Report**

S. P. Lutrell Aug. 1992 16 p
(AD-A258222; DRA-Memo-4669; DRIC-BR-313438) Avail: CASI HC A03/MF A01

In this memorandum we present an informally argued derivation of the properties of topographic vector quantizers in the limit of a large codebook size. In particular, we prove that the code vector density does not depend on one's choice of neighborhood function, provided that we use the minimum distortion (rather than the nearest neighbor) encoding prescription. This result suggests that widespread use of the nearest neighbor prescription in topographic mapping networks is fundamentally misguided. It would be advisable to remember that the nearest neighbor prescription is assumed not derived, so its adherents must accept defeat gracefully. GRA

**N93-18123#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.

**METHOD OF PREPARING A DIAMOND-ABRASIVE MIXTURE**

M. S. Pivovarov, D. D. Loginenko, A. V. Skripnik, O. P. Shelyakov, and L. F. Polashchenko 6 Nov. 1992 5 p Transl. into ENGLISH of Russian Patent No. 313842, (9 Mar. 1970) p 1
(AD-A258228; FASTC-ID(RS)T-0505-92) Avail: CASI HC A01/MF A01

The invention pertains to the manufacturing of diamond tools. A method is known in which the diamond-abrasive mixture is prepared by means of mixing the abrasive grain with a vulcanite binder. The purpose of the invention is to ensure the grinding of the vulcanite binder and the uniform distribution of components. GRA

**N93-18157#** Pennsylvania Univ., Philadelphia. Dept. of Chemistry.

**POLY(ETHYLENE OXIDE)-BASED Zn(2) HALIDE ELECTROLYTES Technical Report, 31 May 1991 - 30 Jun. 1992**

H. Yang and G. C. Farrington 12 Jun. 1992 42 p
(Contract N00014-90-J-1559)
(AD-A258331; Rept-1992-24) Avail: CASI HC A03/MF A01

Poly(ethylene oxide) (PEO)-based Zn(II) halide electrolytes with optimized compositions exhibit rather high conductivities compared to other PEO solutions of divalent cation salts. Chemical diffusion studies have clearly demonstrated that both Zn(II) and Br(-I) are mobile. It appears that Zn(H) cations occur in two forms, one associated with the ether oxygens and another associated with the anions. It is reasonable that the former should be less mobile than the latter. Regrettably, quantitative measurement of the transference number and diffusion coefficients of the charge carriers using electrochemical techniques proved difficult. Other measurements found that the value of Tg for the completely amorphous forms of the electrolytes increases linearly with the mole ration of Zn/O, indicating that Zn(II) cations interact with ether oxygens in the PEO chains to form inter- and/or intrachain cross-links. GRA

**N93-18158#** Pennsylvania Univ., Philadelphia. Dept. of Chemistry.

**THE EFFECT OF LOW MOLECULAR WEIGHT ADDITIVES ON THE PROPERTIES OF POLY (ETHYLENE OXIDE)-BASED Zn(2) AND Li(1) ELECTROLYTES Technical Report, 31 May 1991 - 30 Jun. 1992**

H. Yang, L. L. Yang, and G. C. Farrington 12 Jun. 1992 22 p
(Contract N00014-90-J-1559)
(AD-A258332; Rept-1992-25) Avail: CASI HC A03/MF A01

The incorporation of low molecular weight additives significantly improves the conductivity of both PEO-based ZnBr2 and LiClO4 electrolytes from 0 to 100 deg C, particularly at room temperature and below. Apparently additives have two effects: (1) to increase the segmental mobility of the PEO chains in the amorphous conducting phase, and therefore, increase the mobility of charge carriers; and (2) to increase the degree of salt dissociation in the amorphous conducting phase and thus increase the number of charge carriers. The effectiveness of additives in improving conductivity is greatly influenced by the type of salts involved. GRA

**N93-18218#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.

**DEVICE FOR APPLYING POWDER COATINGS**

V. A. Belyy 6 Nov. 1992 6 p Transl. into ENGLISH of Russian Patent No. 276381, (9 Dec. 1966) p 1-2
(AD-A258229; FASTC-ID(RS)T-0506-92) Avail: CASI HC A02/MF A01

A device for applying powder coatings which is made in the form of a vertical chamber is described. This device is equipped with devices for feeding the parts to be coated into its upper section, and the reception of the coated parts in its lower section, and also for feeding the air-powder mixture into it. Characterized by the fact that for controlling the movement of the parts to be coated inside of the chamber the latter is equipped with controllable electromagnets which are mounted on its walls. Author

**N93-18229*#** Exfluor Research Corp., Austin, TX.

**THE DEVELOPMENT OF NEW, LOW-COST PERFLUOROALKYLETHER FLUIDS WITH EXCELLENT LOW AND HIGH-TEMPERATURE PROPERTIES Final Report, 14 Apr. 1986 - 13 Apr. 1988**

Thomas R. Bierschenk, Hajimu Kawa, Timothy J. Juhlke, and Richard J. Lagow May 1988 47 p
(Contract NAS3-24856; RTOP 505-63-1A)
(NASA-CR-190865; NAS 1.26:190865) Avail: CASI HC A03/MF A01

A series of perfluoroalkylether (PFAE) fluids were synthesized by direct fluorination. Viscosity-temperature properties, oxidation stabilities, oxidation-corrosion properties, and lubricity were determined. The fluids were tested in the presence of common elastomers to check for compatibility. The bulk modulus of each was measured to determine if any could be used as nonflammable aircraft hydraulic fluid. It was determined that as the carbon to oxygen ratio decreases, the viscometric properties improve, the fluids may become poor lubricants, the bulk modulus increases, the surface tension increases, and the fluid density increases. The presence of difluoromethylene oxide units in the polymer does not seriously lower the oxidation and oxidation-corrosion stabilities as long as the difluoromethylene oxide units are separated by other units. Author

**N93-18256#** University of Northern Illinois, De Kalb. Dept. of Chemistry.
**IMPEDANCE AND VOLTAMMETRIC STUDIES OF ELECTROGENERATED POLYANILINE CONDUCTING FILMS**
Giselle Sandi and Petr Vanysek 14 Dec. 1992 38 p
(Contract N00014-91-J-1058)
(AD-A258328; TR-046) Avail: CASI HC A03/MF A01

Polyaniline films were electrochemically synthesized from three acidic media; sulfuric, hydrochloric and perchloric acids. Cyclic voltammetry was used in the electrosynthesis and the effects of voltammetric parameters on the properties of the films were investigated. The main tool of film characterization was impedance spectroscopy. Semiautomated plotting of three-dimensional Argand diagrams with potential parameter was used for synoptic view of the system and nonlinear least square data fitting was used for rigorous treatment. Charge storage capacity, resistance and changes in constant phase element parameters are analyzed in relation to the use of three acidic media. GRA

**N93-18265#** Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry.
**PRECERAMIC POLYMERS: PAST, PRESENT AND FUTURE**
Dietmar Seyferth 2 Nov. 1992 31 p
(Contract N00014-91-J-1590)
(AD-A258327; TR-37) Avail: CASI HC A03/MF A01

A review of preceramic polymer chemistry is given. Preceramic polymers are needed because of high technology applications which arose in our aerospace age. A discussion of the early work in Germany and Japan leads to an enumeration of the requirements that must be met if a polymer is to be a useful precursor in pyrolytic ceramic synthesis. Seven current research directions in preceramic polymer chemistry are discussed and the at present uncertain future of preceramic polymer technology is pointed out. GRA

**N93-18329*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AN INTERIM OVERVIEW OF LDEF MATERIALS FINDINGS**
Brad A. Stein Dec. 1992 58 p
(RTOP 506-48-91-08)
(NASA-TM-107664; NAS 1.15:107664) Avail: CASI HC A04/MF A01

The flight and retrieval of the National Aeronautics and Space Administration's Long Duration Exposure Facility (LDEF) provided an opportunity for the study of the low-Earth orbit (LEO) environment and long-duration space environmental effects (SEE) on materials that is unparalleled in the history of the U.S. Space Program. The remarkable flight attitude stability of LDEF enables specific analyses of various individual and combined effects of LEO environmental parameters on identical materials on the same space vehicle. This paper provides an overview of the interim LDEF materials findings of the Principal Investigators and the Materials Special Investigation Group. In general, the LDEF data is remarkably consistent; LDEF will provide a 'benchmark' for materials design data bases for satellites in low-Earth orbit. Some materials were identified to be encouragingly resistant to LEO SEE for 5.8 years; other 'space qualified' materials displayed significant environmental degradation. Molecular contamination was widespread; LDEF offers an unprecedented opportunity to provide a unified perspective of unmanned LEO spacecraft contamination mechanisms. New material development requirements for long-term LEO missions have been identified and current ground simulation testing methods/data for new, durable materials concepts can be validated with LDEF results. LDEF findings are already being integrated into the design of Space Station Freedom. Author

**N93-18345#** Case Western Reserve Univ., Cleveland, OH.
**PSEUDOMORPHIC STABILIZATION OF DIAMOND ON NON-DIAMOND SUBSTRATES, PART 1. DIAMOND GROWN ON SINGLE CRYSTAL BERYLLIUM OXIDE, PART 2. ANOMALOUS BAND GAP BEHAVIOR AND PHASE STABILITY OF c-BN/DIAMOND ALLOYS Interim Report, 1 Jan. 1991 - 30 Sep. 1992**
A. Argoitia, J. C. Angus, L. Wang, X. I. Ning, and P. Pirouz 12 Oct. 1992 47 p
(Contract N00014-89-J-1631)
(AD-A257845) Avail: CASI HC A03/MF A01

Diamond was grown on single crystal beryllium oxide by hot-filament chemical vapor deposition. Individual diamond crystals grew epitaxially on the basal plane of BeO with the epitaxial relationship: (111)(sub diamond) parellel to /0001/ and a group of zone axes (11'0)(sub diamond) rotated by less than 6 deg from a group of zone axes (112'0)(sub BeO). Electronic structure calculations of mixed crystals of c-BN and diamond show pronounced band gap bowing. The calculations predict only very limited mutual solubility in the solid state. GRA

**N93-18368#** Pennsylvania Univ., Philadelphia. Dept. of Chemistry.
**POLYANILINE: SYNTHESIS, CHEMISTRY AND PROCESSING Technical Report, 31 May 1991 - 30 Jun. 1992**
A. G. MacDiarmid and A. J. Epstein 19 Jun. 1992 28 p
(Contract N00014-90-J-1559)
(AD-A258330; Rept-1992-34) Avail: CASI HC A03/MF A01

The polyanilines and their derivatives are a large class of mixed oxidation state polymers which can be synthesized by the oxidative polymerization of the appropriate monomeric aniline. Certain oxidation states of the polymer can be doped to the metallic conducting regime either by aqueous protonic acids or by partial oxidation. The synthesis and key chemical reactions of the intrinsic properties of the doped polymer by stretch-orientation which results in significant increases in conductivity, crystallinity and tensile strength will be described. GRA

**N93-18370*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**FOUR SPACE APPLICATION MATERIAL COATINGS ON THE LONG-DURATION EXPOSURE FLIGHT (LDEF)**
John J. Scialdone and Carroll H. Clatterbuck Washington Nov. 1992 27 p
(RTOP 313-030-09-01-25)
(NASA-TM-104574; Rept-93B00009; NAS 1.15:104574) Avail: CASI HC A03/MF A01

Four material coatings of different thickness were flown on the LDEF to determine their ability to perform in the harsh space environment. The coatings, located in the ram direction of the spacecraft, were exposed for 10 months to the low-Earth orbit (LEO) environment experienced by the LDEF at an orbit of 260 nautical miles. They consisted of indium oxide (In2O3), silicon oxide (SiO(x)), clear RTV silicone, and silicone with silicate-treated zinc oxide (ZnO). These coatings were flown to assess their behavior when exposed to atomic oxygen and to confirm their good radiative properties, stability, electrical conductivity, and resistance to UV exposure. The flown samples were checked and compared with the reference unflown samples using high-magnification optical inspection, ESCA analysis, weight changes and dimensional changes. These comparisons indicated the following: The 1000 A SiO(x) coating eroded uniformly, with minor changes in its radiative properties. The 100 A of In2O3 coating eroded completely down to the Kapton backing, with resultant losses of reflectance. The RTV-615 showed erosion, with carbon (C) content losses, while the Si remained constant, with a doubling of the oxygen (O) concentration. The RTV-615 silicone with K2SiO3-treated ZnO changed from flat to glossy white in appearance. It lost C, was etched, and increased its O content. The upper layers showed no remaining Zn or K. Losses of reflectance occurred within certain wavelength bands. It was not possible to evaluate the experimental oxygen reaction rate using the calculated atomic oxygen fluence of 2.6 x 10(exp 20) atoms/cm(exp 2) for the exposure of these coatings during the flight. The bakeout of the coatings was not carried out prior to the flight. Hence, the coating weight and dimensional losses included losses by outgassing products. Author

**N93-18418#** Southwest Research Inst., San Antonio, TX. Fuels and Lubricants Research Facility.
**EVALUATION OF HIGH-TEMPERATURE LUBRICANTS FOR LOW-HEAT REJECTION DIESEL ENGINES Interim Report, Oct. 1983 - Mar. 1988**
Edwin A. Frame Sep. 1992 72 p
(Contracts DAAK70-82-C-0001; DAAK70-87-C-0043; DA Proj. 1L2-63001-D-150)
(AD-A257893; BFLRF-283) Avail: CASI HC A04/MF A01

A single-cylinder diesel engine was modified to simulate a low-heat rejection (LHR) engine, and it was used to develop lubrication requirements for future Army LHR diesel engines. Several high-temperature lubricant (HTL) candidates were evaluated, and the simulated LHR engine discriminated HTL deposition performance over a range of engine cylinder wall temperatures (CWT's). Three HTL's were identified that had promising performance at CWT's of 600 F (316 C) while none were adequate at 650 F (343 C). Oil was collected and analyzed from the ring zone of the simulated LHR engine. Oil degradation was as much as 3.7 times more severe in the ring zone as compared to the oil sump. Preliminary oxidation and friction-wear bench tests were investigated. New and used oil analyses flow charts were developed, and analytical techniques to separate and identify HTL additives and base stocks were developed. GRA

**N93-18437#** Sandia National Labs., Livermore, CA.
**TEACHING POLYMERS TO FOLD**
R. S. Judson Oct. 1992 18 p
(Contract DE-AC04-76DP-00789)
(DE93-002670; SAND-92-8625) Avail: CASI HC A03/MF A01

A new method is presented for predicting folding pathways of polymers. The folding pathway is described as a generic program or sequence of logical steps of such a form that a computer can carry them out to produce a folded structure. A genetic algorithm (GA) is used to learn specific sequences or folding pathways that carry a denatured conformation into a target final conformation. The method is demonstrated on a model 2-dimensional polymer for which the global energy minimum is known. The GA learns a program that will fold a denatured polymer into its global energy minimum conformation. DOE

**N93-18530#** Nebraska Univ., Lincoln. Dept. of Electrical Engineering.
**PROGRESS REPORT ON CONDUCTIVE PAINTS, 3 AUGUST - 30 SEPTEMBER 1992**
R. J. Soukup and N. J. Ianno 1992 7 p
(Contract DE-FG01-92CE-15974)
(DE93-001353; DOE/CE-15974/T1) Avail: CASI HC A02/MF A01

Several different paint deposition methods (spraying, rolling, spinning) were explored. Adhesion strength and electric resistivity were measured. DOE

**N93-18537#** Oak Ridge National Lab., TN.
**MATERIALS DEVELOPMENT PROGRAM, CERAMIC TECHNOLOGY PROJECT ADDENDUM TO PROGRAM PLAN: COST EFFECTIVE CERAMICS FOR HEAT ENGINES**
Aug. 1992 25 p
(Contract DE-AC05-84OR-21400)
(DE93-003663; ORNL/M-2309) Avail: CASI HC A03/MF A01

This is a new thrust in the Ceramic Technology project. This effort represents an expansion of the program and an extension through FY 1997. Moderate temperature applications in conventional automobile and truck engines will be included along with high-temp. gas turbine and low heat rejection diesel engines. The reliability goals are expected to be met on schedule by end of FY 1993. Ceramic turbine rotors have been run (in DOE's ATTAP program) for 1000 h at 1370 C and full speed. However, the cost of ceramic components is a deterrrent to near-term commercialization. A systematic approach to reducing this cost includes the following elements: economic cost modeling, ceramic machining, powder synthesis, alternative forming and densification processes, yield improvement, system design studies, standards development, and testing and data base development. A draft funding plan is outlined. DOE

**N93-18572#** Wisconsin Univ., Madison.
**DEVELOPMENT OF PHOSPHATE-BASED CERAMIC MEMBRANES**
M. A. Anderson, W. A. Zeltner, and C. G. Hill, Jr. Nov. 1992 67 p
(Contract DE-FG07-91ID-13062)
(DE93-003285; DOE/ID-13062/T1) Avail: CASI HC A04/MF A01

The goal was to develop microporous ceramic membranes by coating sols that contain nanoparticles onto porous ceramic supports. They could be used for either gas phase separations or liquid phase separations involving low molecular weight solutes. This required the synthesis of Sols containing particles in the range from 2 to 10 nm. Procedures for preparing nanoparticulate sols of silica, alumina, and aluminosilicates of various compositions are given. Unsupported ceramic membranes prepared from these sols had mean pore diameters of less than 10 Angstroms (silica), ca. 35 Angstroms (aluminosilicate). The alumina membranes display both microporosity (mean pore diameters less than 20 Angstroms) and mesoporosity (mean pore diameters greater than 20 Angstroms). These nanoparticulate sols were deposited onto porous supports. Due to equipment and personnel limitations, only four methods of fabricating supported ceramic membranes were investigated. Dip coating appeared to give the best performance of all of these techniques and was easily implemented. Deposition of particles within porous supports by permformation was also demonstrated. Critical point drying studies of membranes were initiated, but progress was limited. Slip casting could not be successfully used to produce a supported membrane free from cracks. DOE

**N93-18699#** Technical Research Centre of Finland, Espoo. Road, Traffic and Geotechnical Lab.
**ASPHALT MIXTURES MODIFIED WITH TALL OIL PITCHES AND CELLULOSE FIBRES Ph.D. Thesis - Helsinki Univ. of Technology**
Petri Peltonen and Inkeri Heikkila, ed. Apr. 1992 86 p Sponsored by Academy of Finland and Finland Tall Oil companies
(VTT-Pubs-99; ISBN-951-38-4077-8; ETN-93-93074) Copyright Avail: CASI HC A05/MF A01

Tall oil pitch and fiber modified asphaltic mixtures were characterized. Details of the materials tested are given. The tall oil pitches were crude distillation residues of crude tall oil. The cellulose fibers were of a commercial grade and consisted of selected sulphate cellulose and spruce fibers originating from recycled proper materials like from old newspapers. Tall oil pitches formed a very homogenous and stable mixture with bitumen. Soft fall oil pitches were added to bitumen in amounts of 15 to 20 percent of the weight of the hard bitumen. About 35 different testing methods were applied which can be classified as adhesion and composition tests for aggregate and fiber surfaces, bitumen quality tests, and tests for asphalt mixtures. Results of these tests are discussed. They give information on the adhesion and specification properties as well as the properties of asphaltic concretes: stability, resistance against water, wear of tall oil pitch modified asphaltic concretes, and wear of fiber modified asphaltic concretes. ESA

**N93-18708#** Oak Ridge National Lab., TN.
**SHORT RANGE ORDER IN AMORPHOUS POLYCONDENSATES**
C. Lamers, D. Richter, W. Schweika (Forschungszentrum Juelich G.m.b.H., Germany ), J. Batoulis, K. Sommer (Bayer A.G., Leverkusen, Germany ), J. W. Cable, and S Shapiro 1992 6 p Presented at the Determination of Partial Structure Factors of Disordered Matter by Neutron and Anomalous X ray Diffraction, Grenoble, France, 10-11 Sep. 1992
(Contracts DE-AC05-84OR-21400; DE-AC02-76CH-00016)
(DE93-001650; CONF-920995-1) Avail: CASI HC A02/MF A01

The static coherent structure factors S(Q) of the polymer glass Bisphenol-A-Polycarbonate and its chemical variation Bisphenol-A-Polyetherketone, both in differently deuterated versions, have been measured by spin polarized neutron scattering. The method of spin polarization analysis provided an experimental separation of coherent and incoherent scattering and a reliable intensity calibration. Results are compared to structure factors calculated for model structures which were obtained by 'amorphous cell' computer simulations. In general reasonable agreement is found between experiment and simulation; however, certain discrepancies hint at an insufficient structural relaxation in the amorphous cell method. DOE

**N93-18784*#** Ohio State Univ., Cleveland. Dept. of Materials Science and Engineering.
**COMPATIBILITY OF POTENTIAL REINFORCING CERAMICS WITH Ni AND Fe ALUMINIDES Final Technical Report**

William A. T. Clark and Jeffrey A. Moser 10 Dec. 1991 6 p
(Grant NAG3-942)
(NASA-CR-192232; NAS 1.26:192232) Avail: CASI HC A02/MF A01

There is a great deal of interest in the possible utilization of intermetallic compounds in advanced high temperature gas turbine engines. These compounds exhibit a variety of promising properties, including reasonable strength, high melting points, relatively low densities, and good corrosion resistance. However, in general, they also show limited ductilities and toughness, and less than optimum creep strengths at elevated temperatures. In addition, in applications involving advanced gas turbine engines, it is often necessary for candidate materials to have large elastic moduli. The present study is part of a program whose objective is to identify a high temperature fiber reinforced composite. The approach adopted was to fabricate laboratory samples of the combinations of materials considered by Misra, in order to determine the extent to which the thermodynamic calculations can predict phase stability. As many of the ceramic phases considered are not currently available in fiber form, they were added as particulates to the alloy matrices. The ways in which the materials were produced and evaluated are described. Author

**N93-19021#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**PROCESSABILITY OF POLYTHIOPHENE THIN FILMS BY ULTRAVIOLET PHOTO BLEACHING M.S. Thesis**
Derek D. Fletcher 4 Dec. 1992 61 p
(AD-A259043; AFIT/GEP/ENP/92D-03) Avail: CASI HC A04/MF A01

Materials possessing strong chi(sup 3) optical properties such as polythiophene are sought for the production of optical switches. Polythiophene thin films produced by plasma enhanced chemical vapor deposition (CVD) show a surface root mean square (rms) roughness of 10-15 angstroms over single square micron areas which is acceptable for wave guiding in the near IR. Permanently changing the optical properties of such a thin film by exposure to UV radiation (254 nm, 35 mW/sqcm), known as photo bleaching, in hope of creating a refractive index boundary for use in total internal reflection is investigated. After 60 minutes exposure the refractive index shows a slight increase of 0.9 percent at 800 nm. The extinction coefficient shows a change of 218 percent at 500 nm. There is a corresponding increase in absorbance of 160 percent at 500 nm, but this increase is seen to drop off at 700 nm. The thin films are observed to lose thickness exponentially over time as a result of out-gasing in the film. It is not known if the chi(sup 3) property is affected after the 60 minute UV exposure. GRA

**N93-19035*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**FRICTION AND WEAR OF PLASMA-DEPOSITED DIAMOND FILMS**
Kazuhisa Miyoshi, Richard L. C. Wu (Universal Energy Systems, Inc., Dayton, OH.), Alan Garscadden (Wright Lab., Wright-Patterson AFB, OH.), Paul N. Barnes (Wright Lab., Wright-Patterson AFB, OH.), and Howard E. Jackson (Cincinnati Univ., OH.) Jan. 1993 24 p Proposed for presentation at the International Conference on Metallurgical Coatings and Thin Films, San Diego, CA, 19-23 Apr. 1993; sponsored by the American Vacuum Society
(RTOP 506-43-11)
(NASA-TM-105926; E-7431; NAS 1.15:105926) Avail: CASI HC A03/MF A01

Reciprocating sliding friction experiments in humid air and in dry nitrogen and unidirectional sliding friction experiments in ultrahigh vacuum were conducted with a natural diamond pin in contact with microwave-plasma-deposited diamond films. Diamond films with a surface roughness (R rms) ranging from 15 to 160 nm were produced by microwave-plasma-assisted chemical vapor deposition. In humid air and in dry nitrogen, abrasion occurred when the diamond pin made grooves in the surfaces of diamond films, and thus the initial coefficients of friction increased with increasing initial surface roughness. The equilibrium coefficients of friction were independent of the initial surface roughness of the diamond films. In vacuum the friction for diamond films contacting a diamond pin arose primarily from adhesion between the sliding surfaces. In these cases, the initial and equilibrium coefficients of friction were independent of the initial surface roughness of the diamond films. The equilibrium coefficients of friction were 0.02 to 0.04 in humid air and in dry nitrogen, but 1.5 to 1.8 in vacuum. The wear factor of the diamond films depended on the initial surface roughness, regardless of environment; it increased with increasing initial surface roughness. The wear factors were considerably higher in vacuum than in humid air and in dry nitrogen. Author

**N93-19327*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**HIGH TEMPERATURE POLYMER FROM MALEIMIDE-ACETYLENE TERMINATED MONOMERS Patent**
Margaret K. Gerber, inventor (to NASA) and Terry L. St.Clair, inventor (to NASA) 23 Feb. 1993 9 p Filed 3 Dec. 1991 Continuation-in-part of abandoned US-Patent-Appl-SN-528666, filed 18 May 1990
(NASA-Case-LAR-14475-1; US-Patent-5,189,129;
US-Patent-Appl-SN-801868; US-Patent-Appl-SN-528666;
US-Patent-Class-526-262; US-Patent-Class-526-285;
US-Patent-Class-528-322; Int-Patent-Class-C08F-222/40) Avail: US Patent and Trademark Office

Thermally stable, glassy polymeric materials were prepared from maleimide-acetylene terminated monomeric materials by several methods. The monomers were heated to self-polymerize. The A-B structure of the monomer allowed it to polymerize with either bismaleimide monomers/oligomers or bis-acetylene monomers/oligomers. Copolymerization can also take place by mixing bismaleimide and bisacetylene monomers/oligomers with the maleimide-acetylene terminated monomers to yield homogenous glassy polymers.
Official Gazette of the U.S. Patent and Trademark Office

**N93-19332*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OXIDATION RESISTANT OVERLAY COATINGS FOR LOW EXPANSION SUBSTRATES Patent Application**
W. J. Brindley, inventor (to NASA), R. A. Miller, inventor (to NASA), J. L. Smialek, inventor (to NASA), and C. J. Rouge, inventor (to NASA) 16 Dec. 1992 18 p
(NASA-Case-LEW-15154-1; NAS 1.71:LEW-15154-1;
US-Patent-Appl-SN-993743) Avail: CASI HC A03/MF A01

A low thermal expansion oxidation resistant coating utilizes an oxidation resistant alloy and an inert low thermal expansion phase which act to reduce overall thermal expansion. This coating is applied to a low thermal expansion substrate. NASA

**N93-19388*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**CROSSLINKED POLYIMIDES PREPARED FROM N-(3-ETHYNYLPHENYL)MALEIMIDE Patent**
Margaret K. Gerber, inventor (to NASA) and Terry L. St.Clair, inventor (to NASA) 23 Feb. 1993 5 p Filed 3 Dec. 1991 Continuation-in-part of abandoned US-Patent-Appl-SN-528666, filed 18 May 1990
(NASA-Case-LAR-14774-1; US-Patent-5,189,127;
US-Patent-Appl-SN-801867; US-Patent-Appl-SN-528666;
US-Patent-Class-526-262; US-Patent-Class-526-285;
US-Patent-Class-528-322; Int-Patent-Class-C08F-222/40) Avail: US Patent and Trademark Office

The compound N-(3-ethynylphenyl)maleimide (NEPMI) was used to prepare thermally stable, glassy polyimides which did not exhibit glass transition temperatures below 500 C. NEPMI was blended with the maleimide of methylene dianiline (BMI) and heated to form the polyimide. NEPMI was also mixed with Thermid 600 R, a commercially available bisethynyl oligomeric material, and heated to form a thermally stable, glassy polyimide. Lastly, NEPMI was blended with both BMI and Thermid 600 R to form thermally stable, glassy polyimides.
Official Gazette of the U.S. Patent and Trademark Office

**N93-19439#** Delaware Univ., Newark.
**HIGH STRAIN-RATE COMPRESSION TESTING OF A CERAMIC MATRIX COMPOSITE M.S. Thesis**
James M. Parker 1 Dec. 1992 101 p Sponsored by Army Student Detachment
(AD-A258802) Avail: CASI HC A06/MF A02

A particle reinforced ceramic matrix composite was compression tested at high strain rates to examine its behavior under increasing high strain rates. The composite was manufactured by the Lanxide DIMOX melt oxidation process and consisted of an Al2O3/Al matrix with SiC particulate

reinforcement. The high strain-rate testing was conducted using a Split-Hopkinson Pressure Bar. The composite was tested at four mean strain rate ranges from 38.3/sec to 291.3/sec. From the test data, ultimate stresses, strains, and strain rates were calculated along with elastic moduli. Optical and scanning microscopy were performed on both fractured and whole tested specimens. Additional low strain-rate compression testing was performed at strain rates of 3.509/sec and .351/sec. GRA

**N93-19632#** Los Alamos National Lab., NM.
**COMPARATIVE COST ANALYSIS OF CERAMIC PROCESSING TECHNIQUES**
P. M. Howe Sep. 1992 43 p
(Contract W-7405-eng-36)
(DE93-003047; LA-12392-MS) Avail: CASI HC A03/MF A01

We made a comparative cost analysis of several processing techniques conventional gas-furnace sintering, electric kiln sintering, microwave sintering, and hot pressing-used for making oxide and nonoxide ceramic parts. It was found that microwave sintering of nonoxide ceramics offers a major economic advantage over hot pressing. This advantage (cost reduction by a factor of four or larger) is primarily a result of higher throughputs. The cost advantage is increased by low material costs and microwave sintering to near-net shape. The estimated cost saving is not sensitive to changes in estimated throughputs for microwave sintering. The estimated cost saving is very sensitive to changes in the throughput for hot pressing, as pressing rates are typically very low. For oxides, microwave sintering does not currently offer a clear economic advantage over conventional gas or electric kilns. Neither electric kilns nor microwave systems have the high-volume effluent problem that gas kilns have. Under conditions where tight control of effluents is required for environmental reasons, gas-fired kilns may be significantly more expensive. Because close control over processing factors is required for high yields, microwave technology should provide a strong advantage where product specifications are very demanding. Even tighter process control should be attainable through a combination of microwave and conventional heating. Product yield in the sintering step exerted the greatest influence upon total part cost of any factors investigated because yield affects the total cost as a multiplicative factor. Of the additive inputs investigated, control of material costs offered the greatest opportunity for additional cost saving. DOE

**N93-19851#** Naval Surface Warfare Center, Dahlgren, VA.
**PERFORMANCE OF REINFORCED POLYMER ABLATORS EXPOSED TO A SOLID ROCKET MOTOR EXHAUST**
C. Boyer, T. Burgess, J. Bowen, K. Deloach, and I. Talmy Oct. 1992 97 p
(AD-A259341; NAVSWC-TR-91-645) Avail: CASI HC A05/MF A02

Summarized in this report is the effort by the Naval Surface Warfare Center Dahlgren Division NSWCDD) and FMC Corporation (a launcher manufacturer) to identify new high performance ablators suitable for use on Navy guided missile launchers (GML) and ships' structures. The goal is to reduce ablator erosion by 25 to 50 percent compared to that of the existing ablators such as MXBE350 (rubber modified phenolic containing glass fiber reinforcement). This reduction in erosion would significantly increase the number of new missiles with higher-thrust, longer burn rocket motors that can be launched prior to ablator refurbishment. In fact, there are a number of new Navy missiles being considered for development and introduction into existing GML's: the Antisatellite Missile (ASM); and the Theater High-Altitude Area Defense (THAAD) Missile. The U.S. Navy experimentally evaluated the eight best fiber-reinforced, polymer composites from a possible field of 25 off-the-shelf ablators previously screened by FMC Corporation. They were tested by the Navy in highly aluminized solid rocket motor exhaust plumes to determine their ability to resist erosion and to insulate. GRA

**N93-19866#** University of Southern California, Los Angeles. Dept. of Materials Science and Engineering.
**DEVELOPMENT OF AN ELECTROCHEMICAL METHOD FOR FIELD TESTING OF PROTECTIVE COATINGS Final Report, 1 Jul. 1990 - 31 Dec. 1991**
Florian Mansfield and C. H. Tsai Oct. 1992 65 p
(Contract N00014-90-J-4123)
(AD-A258754; NCEL-CR-92-012) Avail: CASI HC A04/MF A01

Nine different coating systems on cold rolled steel were tested by recording electrochemical impedence spectroscopy (EIS) data during immersion in 0.5 N NaCl (open to air). One set of samples tested was in the as-received condition and an artificial defect applied. Another set of samples were tested after 2 year's of outdoor exposure at Cape Canaveral, FL. For this set, the susceptibility to cathodic delamination was also evaluated. The as-received condition samples were tested for 1 year. The sample with an all-latex coating was eliminated from further testing since the coating was so porous that the impedance spectra resembled those usually found for bare steel. In long term testing, alkyd/enamel, alkyd/enamel Si-alkyd, and the zinc-rich primer/epoxy polyamide/polyurethane coatings were damaged. For sets of samples tested for 55 days after being outdoors, the only coating damage detected was the alkyd/enamel Si-alkyd coating. The coating properties degraded faster than the as-received sample, indicating that outdoor exposure had weakened the coating. In the cathodic delamination tests, the largest amount of damage occurred on the other alkyd-based coatings. A theoretical analysis of the impedance of polymer coated steel was performed for the purpose of identifying parameters that could be used in the design of a coating monitor. The results of this analysis suggest that the breakpoint frequency f(sub b) and the frequency f(sub min) of the phase angle minimum F(sub min) observed at the high frequencies could be used for this purpose. GRA

**N93-18487#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
**MOLECULAR-SCALE HYBRID POLYMER CERAMICS**
T. W. Giants *In its* Aerospace Sponsored Research 1 Dec. 1991 p 92-94 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-19402*#** Christian Brothers Coll., Memphis, TN. Dept. of Chemical Engineering.
**MATERIAL SELECTION AND EVALUATION OF NEW ENCAPSULATION COMPOUNDS FOR ELECTRIC CABLES FOR LAUNCH SUPPORT SYSTEM**
Asit K. Ray *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 363-389 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

## 28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

**N93-17865#** Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ.
**PERFORMANCE ORIENTED PACKAGING TESTING FOR LIQUID PROPELLANT, XM1846**
Amin Yousef and Frank Chan Dec. 1992 9 p
(AD-A258430; ARAED-TR-92029) Avail: CASI HC A02/MF A01

The results of the tests conducted on a triple pack configuration for liquid propellant (LP) XM1846 are detailed in this report. The requirements stated in the Codes of Federal Regulation (CFR), Title 49, for the shipment of hazardous materials are the basis for these tests. These tests were to ensure that the package tested would provide sufficient protection for the contents throughout the logistic cycle. The tests simulated the rough handling that the package would encounter during transport. The test results indicated that the package was safe for the shipment of the LP. GRA

**N93-17917#** Notre Dame Univ., IN. Dept. of Chemistry and Biochemistry.
**BIODEGRADATION OF JET FUEL-4 (JP-4) IN SEQUENCING BATCH REACTORS Final Annual Report, 1 Sep. 1991 - 31 Aug. 1992**
John A. Bumpus 22 Jun. 1992 22 p
(Grant AF-AFOSR-0404-91)
(AD-A258020; UND-AFOSR-1-91/92; AFOSR-92-0964TR) Avail: CASI HC A03/MF A01

Several bacterial consortia were evaluated for use in the development

of a sequencing batch reactor (SBR) for bioremediation of water contaminated with Jet Fuel-4, (JP-4). All of the bacterial systems tested had some ability to degrade components of JP-4. However, because of its ability to degrade rapidly components of JP-4 and because of it rapid oxygen utilization rates, a bacterial consortium from a soil contaminated with gasoline was selected for further study and was used in the development of an SBR to treat contaminated water. The bench scale SBR developed had a three liter capacity and a 1.5 liter head space. The atmosphere in the head space was changed only during the fill and draw portion of the reactor cycle. At other times, the system was closed and the only oxygen available was that dissolved in the water being treated or in the atmosphere of the headspace. Calculations revealed and experimental data confirmed that this amount of oxygen was sufficient to support extensive bioremediation of water contaminated with JP-4. Results demonstrated that this SBR was consistently able to bioremediate water contaminated with JP-4. During 12 hr cycle times the amount of JP-4 present (30 - 39 mg/L) was always reduced to less than 50 ug/L and usually to below 20 ug/L was always reduced to less than 50 ug/L and usually to below 20 ug/L. GRA

**N93-18242#** Dayton Univ., OH. Research Inst.
**A CONDENSED PHASE TEST CELL ASSEMBLY FOR THE SYSTEM FOR THERMAL DIAGNOSTIC STUDIES (STDS) Final Report, Jun. 1990 - Dec. 1991**
Richard C. Striebich and W. A. Rubey Aug. 1992 64 p
(Contract F33615-90-C-2047)
(AD-A258463; WL-TR-92-2040) Avail: CASI HC A04/MF A01

A reactor and its associated peripherals were designed to be an integral part of the System for Thermal Diagnostic Studies (STDS), a versatile mainframe thermal system. The Condensed Phase Test Cell (CPTC) can be used to conduct experiments for flowing liquids at temperatures up to approximately 800 C and pressures up to 1500 psig. In the area of thermal stability, the CPTC can be used to conduct flowing experiments on jet fuels, jet fuel candidates, and model mixtures at both subcritical and supercritical conditions. By subjecting condensed phase liquids to controlled conditions of temperature, pressures, reactive atmosphere (dissolved oxygen concentration), residence time, and distribution, etc., thermal degradation experiments could be conducted. Product distributions from the exposure of liquid phase and condensed phase material were performed via high pressure liquid sampling valves in line with gas chromatography-mass spectrometry (GC-MS); thus, technique is capable of measuring dissolved fixed gases (nitrogen, oxygen, argon, carbon dioxide, etc.), cracking gases (methane, ethane, ethylene, propylene, etc.) and thermal reaction products of the parent material. GRA

**N93-18260#** Materials Research Labs., Ascot Vale (Australia).
**FLASH RADIOGRAPHIC STUDIES OF HYPERVELOCITY PROJECTILE INTERACTIONS WITH EXPLOSIVES**
T. J. Bussell and M. C. Chick Jul. 1992 28 p
(AD-A258387; MRL-TR-91-51; DODA-AR-006-848) Avail: CASI HC A03/MF A01

This report describes multiple, flash radiographic techniques developed in an investigation aimed at understanding and predicting the processes which occur when a hypervelocity projectile interacts with explosive filled ordnance. Hypervelocity projectiles were generated by shaped charges and characterized by multiple flash radiography. Explosive/metal target assemblies were designed to be representative of various aspects of explosive filled ordnance or components. The techniques have been used to study the projectile impact on bare explosive, penetration through covers into explosive, the supersonic projectile penetration of the explosive and the evolving structure of the bow wave shock that forms several millimetres in front of the projectile tip, the onset and progress of detonation both forward and backward in the explosive and the relative contribution of spall and jets in behind-the-plate initiation of explosives. GRA

**N93-18274*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**PERFORMANCE OF BLASTING CAPS Patent**
Laurence J. Bement, inventor (to NASA), Morry L. Schimmel, inventor (to NASA) (Schimmel Co., Saint Louis, MO.), and Ronnie B. Perry, inventor (to NASA) (PRC Kentron, Inc., Hampton, VA.) 12 Jan. 1993 4 p Filed 5 Apr. 1991 Supersedes N91-28444 (29 - 20, p 3330)
(NASA-Case-LAR-13832-1; US-Patent-5,179,249; US-Patent-Appl-SN-682151; US-Patent-Class-102-202.14; US-Patent-Class-102-275.11; Int-Patent-Class-F42B-3/11) Avail: US Patent and Trademark Office

Common blasting caps are made from an aluminum shell in the form of a tube which is closed at both ends. One end, which is called the output end, terminates in a principal side or face, and contains a detonating agent which communicates with a means for igniting the detonating agent. The improvement of the present invention is a flat, steel foil bonded to the face in a position which is aligned perpendicularly to the longitudinal axis of the tube.

Official Gazette of the U.S. Patent and Trademark Office

**N93-19412*#** Pennsylvania State Univ., University Park. Dept. of Mechanical Engineering and Propulsion Engineering Research Center.
**IGNITION AND COMBUSTION CHARACTERISTICS OF METALLIZED PROPELLANTS Final Report, Jun. 1989 - Dec. 1992**
Stephen R. Turns and D. C. Mueller Jan. 1993 56 p
(Grant NAG3-1004)
(NASA-CR-192285; NAS 1.26:192285) Avail: CASI HC A04/MF A01

Experimental and analytical investigations focusing on secondary atomization and ignition characteristics of aluminum/liquid hydrocarbon slurry propellants were conducted. Experimental efforts included the application of a laser-based, two-color, forward-scatter technique to simultaneously measure free-flying slurry droplet diameters and velocities for droplet diameters in the range of 10-200 microns. A multi-diffusion flame burner was used to create a high-temperature environment into which a dilute stream of slurry droplets could be introduced. Narrowband measurements of radiant emission were used to determine if ignition of the aluminum in the slurry droplet had occurred. Models of slurry droplet shell formation were applied to aluminum/liquid hydrocarbon propellants and used to ascertain the effects of solids loading and ultimate particle size on the minimum droplet diameter that will permit secondary atomization. For a 60 weight-percent Al slurry, the limiting critical diameter was predicted to be 34.7 microns which is somewhat greater than the 20-25 micron limiting diameters determined in the experiments. A previously developed model of aluminum ignition in a slurry droplet was applied to the present experiments and found to predict ignition times in reasonable agreement with experimental measurements. A model was also developed that predicts the mechanical stress in the droplet shell and a parametric study was conducted. A one-dimensional model of a slurry-fueled rocket combustion chamber was developed. This model includes the processes of liquid hydrocarbon burnout, secondary atomization, aluminum ignition, and aluminum combustion. Also included is a model for radiant heat transfer from the hot aluminum oxide particles to the chamber walls. Exercising this model shows that only a modest amount of secondary atomization is required to reduce residence times for aluminum burnout, and thereby maintain relatively short chamber lengths. The model also predicts radiant heat transfer losses to the walls to be only approximately 3 percent of the fuel energy supplied. Additional work is required to determine the effects of secondary atomization on two-phase losses in the nozzle. Author

**N93-19840#** Pennsylvania State Univ., University Park. Dept. of Mechanical Engineering.
**A STUDY OF GAS PHASE CHEMISTRY OF SOLID PROPELLANT INGREDIENTS USING A CO2 LASER Final Report**
Thomas A. Litzinger 1991 43 p
(Contract N00014-89-J-1238)
(AD-A259277) Avail: CASI HC A03/MF A01

This research program was designed to address the critical need for data on the gas-phase chemistry of solid propellants through the development and application of a microprobe mass spectrometer (MPMS) system. The MPMS system was used to study the gas-phase chemical reactions occurring above solid propellant ingredients and actual solid propellants when they are heated and/or ignited by the heat flux from a CO2 laser. In addition to the MPMS system direct and Schlieren photography were used to study the flame structure and twenty-five micron thermocouples were used to measure the gas-phase temperature profile. During the course of this research program, the majority of tests were performed with ammonium dinitramide (ADN), RDX, and an RDX based solid propellant, XM-39. In addition, preliminary studies of two fuel binders, HTPB and BAMO/NMMO, were performed. This report summarizes the experimental

apparatus and the major findings for the oxidizers, ADN and RDX, and the solid propellant, XM-39. GRA

**N93-18492#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**ENERGY STORAGE IN SUPERCRITICAL SOLVENTS**
N. Presser *In its* Aerospace Sponsored Research 1 Dec. 1991 p 105-107 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

## 29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology.*

**N93-17811#** Commissariat a l'Energie Atomique, Grenoble (France). Service de Thermohydrauliques pour les Applications Industrielles.
**FORCED CONVECTION BOILING AND CONDENSATION ON MICROGRAVITY: A CRITICAL APPRAISAL OF THE LITERATURE**
J. M. Delhaye and O. Lebaigue 1991 18 p Presented at 1st European Symposium on Fluids in Space, Ajaccio, France, 18-22 Nov. 1991 Sponsored by CNES
(ETN-93-93362) Avail: CASI HC A03/MF A01

The existing heat transfer correlations for forced convection boiling and condensation are presented with a special emphasis on ammonia as a working fluid. Their application to the available experimental data, which were obtained in low gravity, is discussed. The forced convective boiling was examined in a cylindrical tube, and the following were observed: flow patterns, temperature profiles, forced convection in subcooled liquid, onset of nuleate boiling, net vapor generation, suppression of nucleate boiling, and boiling crisis. The condensation was examined inside both horizontal and vertical cylindrical tubes. The heat transfer coefficient is noted. ESA

**N93-17886*#** Stanford Univ., CA. Center for Materials Research.
**PROTEIN CRYSTAL GROWTH IN LOW GRAVITY Final Technical Report, 27 Apr. 1989 - 31 Dec. 1992**
Robert S. Feigelson Jan. 1993 70 p
(Grant NAG8-774)
(NASA-CR-191770; NAS 1.26:191770; SU-CMR-93-1) Avail: CASI HC A04/MF A01

This Final Technical Report for NASA Grant NAG8-774 covers the period from April 27, 1989 through December 31, 1992. It covers five main topics: fluid flow studies, the influence of growth conditions on the morphology of isocitrate lyase crystals, control of nucleation, the growth of lysozyme by the temperature gradient method and graphoepitaxy of protein crystals. The section on fluid flow discusses the limits of detectability in the Schlieren imaging of fluid flows around protein crystals. The isocitrate lyase study compares crystals grown terrestrially under a variety of conditions with those grown in space. The controlling factor governing the morphology of the crystals is the supersaturation. The lack of flow in the interface between the drop and the atmosphere in microgravity causes protein precipitation in the boundary layer and a lowering of the supersaturation in the drop. This lowered supersaturation leads to improved crystal morphology. Preliminary experiments with lysozyme indicated that localized temperature gradients could be used to nucleate crystals in a controlled manner. An apparatus (thermonucleator) was designed to study the controlled nucleation of protein crystals. This apparatus has been used to nucleate crystals of materials with both normal (ice-water, Rochelle salt and lysozyme) and retrograde (horse serum albumin and alpha chymotrypsinogen A) solubility. These studies have lead to the design of an new apparatus that small and more compatible with use in microgravity. Lysozyme crystals were grown by transporting nutrient from a source (lysozyme powder) to the crystal in a temperature gradient. The influence of path length and cross section on the growth rate was demonstrated. This technique can be combined with the thermonucleator to control both nucleation and growth. Graphoepitaxy utilizes a patterned substrate to orient growing crystals. In this study, silicon substrates with 10 micron grooves were used to grow crystals of catalase, lysozyme and canavalin. In all cases, the crystals grew oriented to the substrate. The supersaturation needed for nucleation and growth was lower on the patterned substrates. In some cases, isolated, large crystals were grown. Author

**N93-18053*#** Worcester Polytechnic Inst., MA. Dept. of Mechanical Engineering.
**MICROGRAVITY IGNITION EXPERIMENT**
Vahid Motevalli, William Elliott, and Keith Garrant [1992] 79 p
(Contract NASw-4435)
(NASA-CR-192057; NAS 1.26:192057) Avail: CASI HC A05/MF A01

The purpose of this project is to develop a flight ready apparatus of the microgravity ignition experiment for the GASCan 2 program. This involved redesigning, testing, and making final modifications to the existing apparatus. The microgravity ignition experiment is intended to test the effect of microgravity on the time to ignition of a sample of alpha-cellulose paper. An infrared heat lamp is used to heat the paper sample within a sealed canister. The interior of the canister was redesigned to increase stability and minimize conductive heat transfer to the sample. This design was fabricated and tested and a heat transfer model of the paper sample was developed. Author

**N93-18387*#** Naval Research Lab., Washington, DC.
**TIME-DEPENDENT COMPUTATIONAL STUDIES OF PREMIXED FLAMES IN MICROGRAVITY Final Report**
K. Kailasanath, Gopal Patnaik, and Elaine S. Oran Jan. 1993 93 p
(NASA Order C-32001-M; RTOP 674-22-05)
(NASA-CR-191051; E-7517; NAS 1.26:191051) Avail: CASI HC A05/MF A01

This report describes the research performed at the Center for Reactive Flow and Dynamical Systems in the Laboratory for Computational Physics and Fluid Dynamics, at the Naval Research Laboratory, in support of NASA Microgravity Science and Applications Program. The primary focus of this research is on investigating fundamental questions concerning the propagation and extinction of premixed flames in earth gravity and in microgravity environments. Our approach is to use detailed time-dependent, multispecies, numerical models as tools to simulate flames in different gravity environments. The models include a detailed chemical kinetics mechanism consisting of elementary reactions among the eight reactive species involved in hydrogen combustion, coupled to algorithms for convection, thermal conduction, viscosity, molecular and thermal diffusion, and external forces. The external force, gravity, can be put in any direction relative to flame propagation and can have a range of values. Recently more advanced wall boundary conditions such as isothermal and no-slip have been added to the model. This enables the simulation of flames propagating in more practical systems than before. We have used the numerical simulations to investigate the effects of heat losses and buoyancy forces on the structure and stability of flames, to help resolve fundamental questions on the existence of flammability limits when there are no external losses or buoyancy forces in the system, to understand the interaction between the various processes leading to flame instabilities and extinguishment, and to study the dynamics of cell formation and splitting. Our studies have been able to bring out the differences between upward- and downward-propagating flames and predict the zero-gravity behavior of these flames. The simulations have also highlighted the dominant role of wall heat losses in the case of downward-propagating flames. The simulations have been able to qualitatively predict the formation of multiple cells and the cessation of cell-splitting. Our studies have also shown that some flames in a microgravity environment can be extinguished due to a chemical instability and without any external losses. However, further simulations are needed to more completely understand upward-propagating and zero-gravity flames as well as to understand the potential effect of radiative heat losses. Author

## 31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

**N93-18000** ESDU International Ltd., London (England).
**FOULING AND SLAGGING IN COMBUSTION PLANT**
Dec. 1992 74 p
(ESDU-92012; ISBN-0-85679-817-7) Avail: ESDU

ESDU 92012 discusses the effects of methods of combustion on the potential for deposition and the consequences for efficiency. Mechanisms by which surfaces become contaminated with particles and deposits as a result of chemical reactions and corrosion are outlined. The principles of combustion are considered in detail in relation to the use of coal, oil, natural gas or waste products as fuel with particular reference to heat transfer surface contamination. The chemical reactions responsible for deposit formation are outlined for the different fuels. Techniques, largely empirical, for assessing fouling and slagging propensity are provided and discussed. Based on an appreciation of the mechanisms of fouling and slagging, techniques are presented for limiting the problems in combustion systems; they include bending, combustion conditions, and the use of additives. Cleaning techniques for use during operation or after shut down are summarized. Some consideration is given to the implications of fouling and slagging for the design of combustion equipment and tentative recommendations are made on good design practice. ESDU

**N93-18281*#** National Aeronautics and Space Administration, Washington, DC.

**METRICATION REPORT TO THE CONGRESS**

Jan. 1990 5 p

(NASA-TM-108600; NAS 1.15:108600) Avail: CASI HC A01/MF A01

The principal NASA metrication activities for FY 1989 were a revision of NASA metric policy and evaluation of the impact of using the metric system of measurement for the design and construction of the Space Station Freedom. Additional studies provided a basis for focusing follow-on activity. In FY 1990, emphasis will shift to implementation of metric policy and development of a long-range metrication plan. The report which follows addresses Policy Development, Planning and Program Evaluation, and Supporting Activities for the past and coming year. Author

**N93-18354*#** National Aeronautics and Space Administration, Washington, DC.

**METRIC TRANSITION Status Report, 30 Jun. 1992**

30 Jun. 1992 13 p

(NASA-TM-108599; NAS 1.15:108599) Avail: CASI HC A03/MF A01

This report describes NASA's metric transition in terms of seven major program elements. Six are technical areas involving research, technology development, and operations; they are managed by specific Program Offices at NASA Headquarters. The final program element, Institutional Management, covers both NASA-wide functional management under control of NASA Headquarters and metric capability development at the individual NASA Field Installations. This area addresses issues common to all NASA program elements, including: Federal, state, and local coordination; standards; private industry initiatives; public-awareness initiatives; and employee training. The concluding section identifies current barriers and impediments to metric transition; NASA has no specific recommendations for consideration by the Congress. Author

**N93-18355*#** National Aeronautics and Space Administration, Washington, DC.

**METRICATION REPORT TO THE CONGRESS Annual Report**

Jan. 1991 5 p

(NASA-TM-108601; NAS 1.15:108601) Avail: CASI HC A01/MF A01

NASA's principal metrication accomplishments for FY 1990 were establishment of metrication policy for major programs, development of an implementing instruction for overall metric policy and initiation of metrication planning for the major program offices. In FY 1991, development of an overall NASA plan and individual program office plans will be completed, requirement assessments will be performed for all support areas, and detailed assessment and transition planning will be undertaken at the institutional level. Metric feasibility decisions on a number of major programs are expected over the next 18 months. Author

**N93-18356*#** National Aeronautics and Space Administration, Washington, DC.

**METRICATION REPORT TO THE CONGRESS**

Feb. 1989 3 p

(NASA-TM-108602; NAS 1.15:108602) Avail: CASI HC A01/MF A01

The major NASA metrication activity of 1988 concerned the Space Station. Although the metric system was the baseline measurement system for preliminary design studies, solicitations for final design and development of the Space Station Freedom requested use of the inch-pound system because of concerns with cost impact and potential safety hazards. Under that policy, however use of the metric system would be permitted through waivers where its use was appropriate. Late in 1987, several Department of Defense decisions were made to increase commitment to the metric system, thereby broadening the potential base of metric involvement in the U.S. industry. A re-evaluation of Space Station Freedom units of measure policy was, therefore, initiated in January 1988. Author

**N93-18357*#** National Aeronautics and Space Administration, Washington, DC.

**METRICATION REPORT TO THE CONGRESS. 1991 ACTIVITIES AND 1992 PLANS**

1991 9 p

(NASA-TM-108603; NAS 1.15:108603) Avail: CASI HC A02/MF A01

During 1991, NASA approved a revised metric use policy and developed a NASA Metric Transition Plan. This Plan targets the end of 1995 for completion of NASA's metric initiatives. This Plan also identifies future programs that NASA anticipates will use the metric system of measurement. Field installations began metric transition studies in 1991 and will complete them in 1992. Half of NASA's Space Shuttle payloads for 1991, and almost all such payloads for 1992, have some metric-based elements. In 1992, NASA will begin assessing requirements for space-quality piece parts fabricated to U.S. metric standards, leading to development and qualification of high priority parts. Author

**N93-18397*#** Alabama Cryogenic Engineering, Inc., Huntsville.

**A HELIUM-3/HELIUM-4 DILUTION CRYOCOOLER FOR OPERATION IN ZERO GRAVITY Final Report, 17 Apr. 1986 - 17 Oct. 1988**

John B. Hendricks 17 Oct. 1988 148 p

(Contract NAS8-37260; SBIR-09.19-8629)

(NASA-CR-183632; NAS 1.26:183632) Avail: CASI HC A07/MF A02

This research effort covered the development of He-3/He-4 dilution cryocooler cycles for use in zero gravity. The dilution cryocooler is currently the method of choice for producing temperatures below 0.3 Kelvin in the laboratory. However, the current dilution cryocooler depends on gravity for their operation, so some modification is required for zero gravity operation. In this effort, we have demonstrated, by analysis, that the zero gravity dilution cryocooler is feasible. We have developed a cycle that uses He-3 circulation, and an alternate cycle that uses superfluid He-4 circulation. The key elements of both cycles were demonstrated experimentally. The development of a true 'zero-gravity' dilution cryocooler is now possible, and should be undertaken in a follow-on effort. Author

**N93-18444#** Universiteit Twente, Enschede (Netherlands).

**OPTIMIZATION OF FLOW-INJECTION ANALYSIS FOR ON-LINE IN-PROCESS CONTROL Ph.D. Thesis**

Ingrid Christiena vanNugteren-Osinga 1991 129 p Sponsored in part by Netherlands Foundation for Chemical Research and Netherlands Technology Foundation

(ETN-92-92826) Avail: CASI HC A07/MF A02

A description of flow injection analysis and how this technique can be used on behalf of online in-process control if the equipment is properly adjusted is given. Subjects needing more attention for adjustments necessary for proper use in process analysis are described. Information concerning the sample dispersion processes can be obtained by determining the impulse-response function of a model. An impulse-response function, how it is determined and be used are explained. The following topics are described: how a filter method related to the Hunt filter can improve the results; how an impulse-response function of a detector can be determined and how this function can be used to optimize the detector: how an impulse-response function of several membrane separation modules can be determined; how different modules of a flow injection system can be optimized by using impulse-response functions; how the impulse-response functions can be used to calculate the final signal of a system; how a hollow membrane fiber can be used to introduce gases and vapors into a flow injection system. The development of a program and equipment, which must be able to perform the analysis automatically and to represent the functioning of the flow injection equipment, is presented. ESA

**N93-18857*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**INTEGRAL FILL YARN INSERTION AND BEATUP METHOD USING INFLATABLE MEMBRANE Patent**
Gary L. Farley, inventor (to NASA) 23 Feb. 1993 9 p Filed 26 Sep. 1991 Supersedes N92-11219 (30 - 2, p 222)
(NASA-Case-LAR-14046-1; US-Patent-5,188,153;
US-Patent-Appl-SN-766597; US-Patent-Class-139-11;
US-Patent-Class-139-DIG.1; US-Patent-Class-139-429;
US-Patent-Class-139-436; Int-Patent-Class-D03D-47/14) Avail: US Patent and Trademark Office

An apparatus and method for integral fill yarn insertion and beatup are disclosed. A modified rapier contains a channel for holding fill yarn. The channel is covered with a flexible and inflatable boot, and an inflating apparatus for this boot is also attached. Fill yarn is inserted into the channel, and the rapier is extended into a shed formed by warp yarn. Next, the rapier is pushed into the fell of the fabric, and the flexible and inflatable cover inflated, which both pushes the yarn into the fell of the fabric and performs beatup. The rapier is withdrawn and the shed closed to complete one step of the weaving process.
Official Gazette of the U.S. Patent and Trademark Office

**N93-19038*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**METHOD AND APPARATUS FOR THREE DIMENSIONAL BRAIDING Patent Application**
Gary L. Farley, inventor (to NASA) 29 Sep. 1992 18 p
(NASA-Case-LAR-14047-1; NAS 1.71:LAR-14047-1;
US-Patent-Appl-SN-953562) Avail: CASI HC A03/MF A01

A machine for three-dimensional braiding of fibers is provided in which carrier members travel on a curved, segmented and movable braiding surface. The carrier members are capable of independent, self-propelled motion along the braiding surface. Carrier member position on the braiding surface is controlled and monitored by computer. Also disclosed is a yarn take-up device capable of maintaining tension in the braiding fiber. NASA

**N93-19103*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**DARK-CYCLE MONITORING OF BIOLOGICAL SUBJECTS ON SPACE STATION FREEDOM**
Sherry Chuang and Arshad Mian Dec. 1992 10 p Presented at the International Conference on Environmental Systems, Seattle, WA, Jul. 1992
(RTOP 476-14-03)
(NASA-TM-103976; A-92184; NAS 1.15:103976) Avail: CASI HC A02/MF A01

The operational environment for biological research on Space Station Freedom will incorporate video technology for monitoring plant and animal subjects. The video coverage must include dark-cycle monitoring because early experiments will use rodents that are nocturnal and therefore most active during the dark part of the daily cycle. Scientific requirements for monitoring during the dark cycle are exacting. Infrared (IR) or near-IR sensors are required. The trade-offs between these two types of sensors are based on engineering constraints, sensitivity spectra, and the quality of imagery possible from each type. This paper presents results of a study conducted by the Biological Flight Research Projects Office in conjunction with the Spacecraft Data Systems Branch at ARC to investigate the use of charged-coupled-device and IR cameras to meet the scientific requirements. Also examined is the effect of low levels of near-IR illumination on the circadian rhythm in rats. Author

**N93-18918*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**HELIUM COMPRESSORS FOR CLOSED-CYCLE, 4.5-KELVIN REFRIGERATORS**
T. R. Hanson *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 246-253 (For primary document see N93-18897 06-32)
(RTOP 310-30-43-10-11)
Avail: CASI HC A02/MF A03

## 32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

**N93-17903#** Naval Postgraduate School, Monterey, CA.
**COUPLING LOSSES IN MULTIPLE BEAM ANTENNAS M.S. Thesis**
Randall J. Tucker Sep. 1992 87 p
(AD-A257494) Avail: CASI HC A05/MF A01

The relationship between beam coupling losses in multiple beam antennas and pattern parameters such as beamwidth and sidelobe level is investigated. A computer algorithm to calculate the coupling coefficients for arbitrary number of beams is implemented using MATLAB. Gain-loss data for various array amplitude distributions is presented. GRA

**N93-17904#** Naval Postgraduate School, Monterey, CA.
**WAVELET-BASED MULTIRESOLUTION ANALYSES OF SIGNALS M.S. Thesis**
Mark R. Kalmbach Jun. 1992 102 p
(AD-A257496) Avail: CASI HC A06/MF A02

Signal analysts have traditionally relied on the Discrete Fourier Transform and various data windowing schemes for signal detection and classification. Some signals, notably those of a transient nature, are inherently difficult to analyze with these traditional tools. The Discrete Wavelet Transform has recently generated considerable interest in several areas of digital signal processing and a determination of its suitability as a signal analysis tool is necessary. Associated with wavelet theory is the concept of multiresolutional analyses which allow examination of a signal at different scales. This thesis investigates dyadic discrete wavelet decompositions of signals. A new multiphase wavelet transform is proposed and investigated. The multiphase transform technique is shown to be useful in transient signal analysis. Several MATLAB TM programs that perform multiresolutional analyses with various supporting features are provided. GRA

**N93-17930*#** Mississippi State Univ., Mississippi State. Dept. of Electrical and Computer Engineering.
**DATA COMMUNICATION NETWORK AT THE ASRM FACILITY Second Year Final Report, 6 Feb. 1992 - 5 Feb. 1993**
Robert J. Moorhead, II, Wayne D. Smith, Ravi Nirgudkar, Zhifan Zhu, and Walter Robinson 5 Feb. 1993 89 p
(Grant NAG8-866)
(NASA-CR-192085; NAS 1.26:192085) Avail: CASI HC A05/MF A01

The main objective of the report is to present the overall communication network structure for the Advanced Solid Rocket Motor (ASRM) facility being built at Yellow Creek near Iuka, Mississippi. This report is compiled using information received from NASA/MSFC, LMSC, AAD, and RUST Inc. As per the information gathered, the overall network structure will have one logical FDDI ring acting as a backbone for the whole complex. The buildings will be grouped into two categories viz. manufacturing critical and manufacturing non-critical. The manufacturing critical buildings will be connected via FDDI to the Operational Information System (OIS) in the main computing center in B 1000. The manufacturing non-critical buildings will be connected by 10BASE-FL to the Business Information System (BIS) in the main computing center. The workcells will be connected to the Area Supervisory Computers (ASCs) through the nearest manufacturing critical hub and one of the OIS hubs. The network structure described in this report will be the basis for simulations to be carried out next year. The Comdisco's Block Oriented Network Simulator (BONeS) will be used for the network simulation. The main aim of the simulations will be to evaluate the loading of the OIS, the BIS, the ASCs, and the network links by the traffic generated by the workstations and workcells throughout the site.
Author

**N93-17960#** Naval Postgraduate School, Monterey, CA.
**PERFORMANCE EVALUATION OF A RADAR BY COMPUTER M.S. Thesis**

Amnauy Thongrod Sep. 1992 53 p
(AD-A257543) Avail: CASI HC A04/MF A01

This thesis evaluates the radar range performance of Airport Surveillance Radar (ASR-9) in thermal noise, as well as in the presence of clutter and jamming. Radar software available from Artech House was used for the performance evaluation. Computation of detection range in this software is based on empirical calculation of detectability factor in contrast to Marcum-Swerling method which is based on standard radar detection theory. ASR-9 was chosen because it has no military significance and data on it is easily available. GRA

**N93-17962#** Naval Postgraduate School, Monterey, CA.
**A STUDY OF CURRENT WORLD TELECOMMUNICATIONS AND A PROJECTION OF THE FUTURE M.S. Thesis**
Costas Karageorgis 24 Sep. 1992 116 p
(AD-A257545) Avail: CASI HC A06/MF A02

Telecommunications today are important factors in economic and social progress. The last decades of the 20th century and the early years of the 21st have been characterized as the Information Age. Telecommunications, the movement of information through distances, is absolutely critical to the economic and military survival of nations. This thesis is an attempt to predict the future of telecommunications, by studying and analyzing the past and present. First it examines the meaning of telecommunications today and some basics of information transmission. The current status of telecommunications is then presented, by examining the regional profiles as they are divided by the International Telecommunications Union. A number of statistical studies are given, which present a thorough picture of current world telecommunications. In an effort to predict future industry trends, the competition among the three largest telecommunications markets, U.S.A., Japan and the European Community, is also considered by looking at their present telecommunications industry, the efforts they make to improve their technology, and their plans for future investment. Finally, some major technological trends including BISDN, the use of fiber technology in the communications loop, and the use of solitons are examined. The new Metropolitan Area Network Protocol, FDDI-2 is also reviewed. GRA

**N93-17963#** Naval Postgraduate School, Monterey, CA.
**IMPROVING SECURITY IN THE FIBER DISTRIBUTED DATA INTERFACE (FDDI) PROTOCOL M.S. Thesis**
Benjamin E. Jones Sep. 1992 73 p
(AD-A257546) Avail: CASI HC A04/MF A01

The arrival of high speed packet switched fiber optic LAN's has allowed local area design architectures to be used for larger metropolitan area network (MAN) implementations. The current LAN security mechanisms used in larger and faster fiber optic LAN's and MAN's are often inappropriate or unacceptable for use with emerging applications. The protocol of the Fiber Distributed Data Interface (FDDI) standard provides a natural means for message integrity and availability verification. However, privacy in FDDI is facilitated at higher layers through a generic LAN standard. This thesis proposes a modification to the FDDI protocol implemented at the medium access control (MAC) sublayer, which integrates a confidentiality mechanism for data transfer. The modification provides a simple comprehensive security package to meet the high performance needs of current and emerging applications. In the proposed modification, the inherent properties of the ring are exploited using a unique Central Key Translator to distribute initial session keys. A symmetric bit stream cipher based on modulo2 addition is used for encryption/decryption by the transmitting and receiving stations. Part of the plain text from transmitted message frames is used as feedback to generate new session keys. GRA

**N93-17982#** Naval Postgraduate School, Monterey, CA.
**A TECHNICAL REVIEW OF CELLULAR RADIO AND ANALYSIS OF A POSSIBLE PROTOCOL M.S. Thesis**
William D. Reese Sep. 1992 86 p
(AD-A257560) Avail: CASI HC A05/MF A01

Radio and television technology made the field of cellular radio possible. This thesis shows the development of radio and television technology from both a historical and technical aspect. A review of the important researchers and their contributions is followed by a technical explanation of the theories behind electromagnetic radiation of radio and television signals and the technology which was developed to implement such transmissions. The evolution of development which the paper outlines begins with some of the first theories about electricity and magnetism and the subsequent mathematical foundation developed to explain them. This is followed by a number of experimental and developmental researchers and their contributions. The bulk of the paper is concentrated on explaining the earliest generations of radio and all generations of television. The major components of both radio and television are described in detail along with an explanation of what they do and how they work. Such components, in many cases, found important uses in fields outside those for which they were developed. A brief overview of the regulatory environment of each technology and the U.S. and international standardization efforts is also included. Finally, the paper illustrates a modern-day application of radio technology--the cellular radio industry. A description of the components and their functions is followed by a possible cellular radio protocol and analysis. GRA

**N93-18023#** Defence Research Agency, Malvern (England).
**A SEGMENTAL HIDDEN MARKOV MODEL FOR SPEECH PATTERN PROCESSING Memorandum Report**
M. J. Russell Jul. 1992 34 p
(AD-A258220; DRA-Memo-4599; DRIC-BR-313437) Avail: CASI HC A03/MF A01

A simple statistical segmental approach to speech pattern modelling, based on segmental hidden Markov models, is proposed which addresses some of the limitations of conventional hidden Markov model based methods. The most important features of the new approach are the use of an underlying semi-Markov process to model speech at the segment level, rather than time-synchronous frame level, and to enable improved segment duration modelling, and the development of a segment model in which separate statistical processes are used to characterize extra-state and intrastate variability, thus making the temporal independence assumption more acceptable within a segment. A basic mathematical analysis of gaussian segmental hidden Markov models is presented and model parameter re-estimation equations are derived. The relationship between the new type of model and variable frame rate analysis and conventional gaussian mixture based hidden Markov models is exposed. GRA

**N93-18181#** Naval Postgraduate School, Monterey, CA.
**CODED PERFORMANCE OF A FAST FREQUENCY-HOPPED NONCOHERENT BFSK RATIO STATISTIC RECEIVER OVER A RICIAN FADING CHANNEL WITH PARTIAL-BAND INTERFERENCE M.S. Thesis**
Miguel A. BetancourtRivas Sep. 1992 76 p
(AD-A257580) Avail: CASI HC A05/MF A01

A frequency-hopping, binary frequency shift keying (BFSK) ratio-statistic receiver with multi-hops per data bit is an effective electronic countermeasures (ECCM) system against partial-band jamming interference. Interference is modeled as Gaussian noise. Orthogonal binary signaling and independent fading diversity is considered over frequency-nonselective, slow fading Rayliegh, Rician, and Gaussian channels. A forward error correcting coding scheme is implemented for a 1/2 convolutional code. The probability of bit error is examined for different levels of diversity, thermal noise, severity of fading, fractions of bandwidth jammed, and jamming power. Uncoded and coded system comparisons are done to determine worst case performance. GRA

**N93-18190#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
**CONTRIBUTION TO THE MODELLING OF THE ELECTROMAGNETIC PROPERTIES OF RANDOM DIELECTRIC-CONDUCTOR MIXTURES Ph.D. Thesis - Paris VI Univ. [CONTRIBUTION A LA MODELISATION DES PROPERTES ELECTROMAGNETIQUES DES MELANGES ALEATOIRES DU TYPE DIELECTRIQUE/CONDUCTEUR]**
Thierry Guillot 1992 295 p In FRENCH
(ONERA-NT-1992-3; ETN-93-93046) Avail: CASI HC A13/MF A03

The electromagnetic properties of dielectric-conductor mixtures are investigated and the validity of several 'mixture laws' is discussed. Wideband microwave absorption can not be performed by means of homogeneous materials. Experimentally, it was noticed that some compounds made with small conducting grains dipersed in a dielectric host can be used in radar absorber design. Many 'mixture laws' were derived to model the dielectric permittivity of dielectric conductor mixtures. Though they give good results for mixtures in which grains are separated, they fail in modeling those in which there exist conducting paths between inclusions. If the paths are

tunneling junctions, the mixtures are called 'supercolative'. Electron jumping is responsible for special phenomena: an anomalous direct current conduction threshold; and a 'Jonscher effect' caused by short electrostatic interactions. The mixtures for which the quasi static approximation is not matched inside the conducting medium are considered. It yields an artificial lossy diamagnetic behavior for which a model is derived. Experimental results that show very good agreements with this model are presented. This special effect gives rise to a new method for measuring the electrical conductivity of grain in conducting powders. ESA

**N93-18206#** Air War Coll., Maxwell AFB, AL.
**THE EVOLVING DEFENSE COMMUNICATIONS SYSTEM**
Ann M. Testa and Walter I. Jones May 1992 27 p
(AD-A258335) Avail: CASI HC A03/MF A01

Command, control, and communications (C3) systems 'help lift the fog of war that adds uncertainty to any military operation.' They multiply the effectiveness of weapon systems and are critical components of our nation's warfighting capability. One of these critical systems is the Defense Communications System (DCS) which evolved over the past 30 years. Several factors drove this evolution, including constrained budgets, the need to improve the effectiveness and efficiency of the service provided, compatibility and interoperability, and technological advances. Based on lessons learned from Desert Shield/Desert Storm and the changing environment, force structure, and strategy, it is time to advance the DCS to its next stage. The future DCS must be flexible enough to adapt to any situation anywhere in the world. Mobile, modular building block packages of communications equipment must be available to provide effective communications capability to deployed units immediately upon arrival. Total integration and interoperability among military, commercial, and other government agencies' communication systems is a must if survivable, robust connectivity is going to be available when needed. Integration planning must begin now. GRA

**N93-18207#** Harry Diamond Labs., Adelphi, MD.
**HIGH-ALTITUDE ELECTROMAGNETIC PULSE SURVIVABILITY ASSESSMENT OF THE HARRIS RF-3200 TRANSCEIVER Final Report, 1 Oct. 1989 - 1 Oct. 1991**
William O. Coburn, Eric Nguyen, Ronald J. Reyzer, and Mark H. Mar Sep. 1992 105 p
(AD-A258347; HDL-SR-92-2) Avail: CASI HC A06/MF A02

Harry Diamond Laboratories conducted a high-altitude electromagnetic pulse (HEMP) survivability/vulnerability assessment of a high-frequency transceiver system, the Harris Corporation RF-3200 transceiver and ancillary equipment. The non-developmental item and a hardened version of the RF-3200 system were both HEMP simulation tested. External transient protection devices were HEMP hardened at the various system electrical interfaces. The test and analysis results establish the RF-3200 transceiver system survivability when it is exposed to a HEMP threat environment. GRA

**N93-18241#** Naval Postgraduate School, Monterey, CA.
**ONE AND TWO DIMENSIONAL DISCRETE WAVELET TRANSFORMS M.S. Thesis**
Joey E. Legaspi Sep. 1992 128 p
(AD-A257981) Avail: CASI HC A07/MF A02

Fourier transform techniques have been the favored methods in the analysis of signal and systems. One major drawback of Fourier methods is the difficulty in analyzing transient and/or non-stationary behavior. Recent advances in the field of wavelet theory show much promise in alleviating these problems. This thesis considers the realizations of the wavelet decomposition and reconstruction algorithms for the discrete case. We also present a multiple-phase development as a second and possibly a preferable method for decomposing signals. GRA

**N93-18249#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**A COMPUTER PROGRAM TO CALCULATE PLANEWAVE AVERAGE SPECIFIC ABSORPTION RATE IN A PROLATE SPHEROIDAL MODEL Interim Report, Oct. 1991 - Sep. 1992**
D. J. Hatcher and J. A. DAndrea Aug. 1992 20 p
(NR Proj. MM5-8524)
(AD-A258197; NAMRL-TM-92-3) Avail: CASI HC A03/MF A01

This report documents a computer program that was developed locally to compute the average specific absorption rate (SAR) for any prolate spheroidal target. It was developed using equation 5.10 from the Radiofrequency Radiation Dosimetry Handbook (4th ed). The program, which is IBM-compatible, is capable of calculating the SAR during microwave radiation exposure for all model sizes ranging from a small mouse to a large human. This procedure removes the restriction of using the Radiofrequency Radiation Dosimetry Handbook, which is limited to only a single or, in some cases, a few sizes of spheroid models. GRA

**N93-18251#** Defence Research Establishment, Ottawa (Ontario).
**THE ADVANTAGE OF CYCLIC SPECTRAL ANALYSIS**
Eric April Dec. 1991 56 p
(AD-A258307; DREO-TN-92-4) Avail: CASI HC A04/MF A01

This report shows that cyclic spectral analysis, as a general tool for signal spectral analysis, is much superior to more conventional spectral analysis. Three major advantages are pointed out: (1) its signal's discriminatory capability enables signal selectivity (even for highly corrupted environments); (2) it provides a richer domain for signal analysis; and (3) the theory of spectral correlation allows much more complete mechanism for modelling communication signals in several applications. A conceptual view of the cyclic spectrum is presented along with a working example. A strong mathematical foundation for the theory of spectral correlation involved in cyclic spectral analysis is provided. Finally, investigations are made on some interesting applications where exploitation of the inherent redundancy associated with spectral correlation can be used advantageously. GRA

**N93-18262#** Massachusetts Inst. of Tech., Lexington.
**A BANDWIDTH EXTRAPOLATION TECHNIQUE FOR IMPROVED RANGE RESOLUTION OF COHERENT RADAR DATA, REVISION 1**
Kevin M. Cuomo 4 Dec. 1992 34 p
(Contract F19628-90-C-0002)
(AD-A258462; CJP-60-Rev-1; ESC-TR-92-172) Avail: CASI HC A03/MF A01

A linear predictive bandwidth extrapolation (BWE) technique is introduced as a means of significantly improving the range resolution of pulse-compressed coherent radar data. Pulse compression schemes based on conventional Fourier techniques are efficient and robust; however, they often suffer from relatively poor resolution. This report describes the use of an autoregressive (AR) time-series model to extrapolate the spectral bandwidth of each uncompressed radar return signal. Subsequent Fourier transformation of the expanded spectral goal yields recompressed pulses with better range resolution than obtainable from conventional Fourier techniques. The linearity of the BWE process produces recompressed pulses that have a calibrated amplitude and phase response, thus allowing for a meaningful interpretation of the RCS and phase signatures of the target. In addition, high resolution range-Doppler images of the target can be generated since the coherence properties of the recompressed pulses are maintained by the BWE process. Simulations, radar range data, and applications of this technique to field data show very promising results. GRA

**N93-18263#** Naval Postgraduate School, Monterey, CA.
**APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY JOURNAL, VOLUME 7, NUMBER 2, WINTER 1992**
A. H. Fleming and K. H. Joyner 1992 196 p
(AD-A258483) Avail: CASI HC A09/MF A03

A symposium of the methodologies employed by the authors of the selected papers is presented. The first three papers present different methodologies for solving whole-body problems. The next four papers are applied to hyperthermia and concern levels of deposition in tissue. The final two papers examine methods of stimulation of neurons and tissues. I.I.C.

**N93-18284*** National Aeronautics and Space Administration. Pasadena Office, CA.
**COMPOSITE VIDEO AND GRAPHICS DISPLAY FOR CAMERA VIEWING SYSTEMS IN ROBOTICS AND TELEOPERATION Patent**
Daniel B. Diner, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) and Steven C. Venema, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 26 Jan. 1993 11 p Filed 17 Jun. 1991 Supersedes N92-10126 (30 - 1, p 25)
(NASA-Case-NPO-17836-1-CU; US-Patent-5,182,641;

US-Patent-Appl-SN-716150; US-Patent-Class-358-103;
US-Patent-Class-358-108; US-Patent-Class-358-101;
US-Patent-Class-358-181; Int-Patent-Class-H04N-7/18;
Int-Patent-Class-H04N-7/00) Avail: US Patent and Trademark Office

A system for real-time video image display for robotics or remote-vehicle teleoperation is described that has at least one robot arm or remotely operated vehicle controlled by an operator through hand-controllers, and one or more television cameras and optional lighting element. The system has at least one television monitor for display of a television image from a selected camera and the ability to select one of the cameras for image display. Graphics are generated with icons of cameras and lighting elements for display surrounding the television image to provide the operator information on: the location and orientation of each camera and lighting element; the region of illumination of each lighting element; the viewed region and range of focus of each camera; which camera is currently selected for image display for each monitor; and when the controller coordinate for said robot arms or remotely operated vehicles have been transformed to correspond to coordinates of a selected or nonselected camera. Official Gazette of the U.S. Patent and Trademark Office

**N93-18352#** Georgia Tech Research Inst., Atlanta.
**EVALUATION OF EMP/EMI REQUIREMENTS VERSUS CORROSION PREVENTION METHODS Final Report**
Jan W. Gooch, Paul M. Hawley, John K. Daher, and Daniel M. LaGesse 7 Oct. 1992 298 p
(Contract F09603-88-R-2808)
(AD-A257820) Avail: CASI HC A13/MF A03

Final report covers the application of conductive sealants on an E-3 aircraft for nine months and evaluating the Electromagnetic Pulse (EMP) / Electromagnetic Interference (EMI) Requirements and corrosion damage. Also, additional testing was performed on three conductive sealants for corrosion protection via the salt fog chambers. Using conductive sealants will meet both EMP/EMI and corrosion requirements. GRA

**N93-18366#** Mitre Corp., Bedford, MA.
**MONOPOLE ELEMENTS WITH DISK GROUND PLANES ON FLAT EARTH: ATLAS OF DIRECTIVITY, RADIATION EFFICIENCY, RADIATION RESISTANCE, AND INPUT IMPEDANCE**
M. M. Weiner Jun. 1992 208 p
(AD-A257911; MTR-92B0000089) Avail: CASI HC A10/MF A03

Richmond's moment-method programs RICHMOND3 and RICHMOND4 for monopole elements with disk ground planes above flat Earth are used to obtain computer plots of directivity, radiation efficiency, radiation resistance, and input impedance at 15 MHz. Results, in the form of an atlas, are presented as a function of Earth classification for thin, quarter-wave monopole elements whose ground planes or radii 0 to 8 wavenumbers rest on Earth. Results are compared with those for a perfect ground plane (of infinite extent and conductivity) and ground plane in free-space. Sea-water enhancement of radiation efficiency and low-angle directivity by comparing results for sea water with those for medium dry ground. GRA

**N93-18417#** Naval Postgraduate School, Monterey, CA.
**NPSNET: AURAL CUES FOR VIRTUAL WORLD IMMERSION M.S. Thesis**
Leif A. Dahl Sep. 1992 75 p
(AD-A257835) Avail: CASI HC A04/MF A01

NPSNET is a low-cost visual and aural simulation system designed and implemented at the Naval Postgraduate School. NPSNET is an example of a virtual world simulation environment that incorporates real-time aural cues through software-hardware interaction. In the current implementation of NPSNET, a graphics workstation functions in the sound server role which involves sending and receiving networked sound message packets across a Local Area Network, composed of multiple graphics workstations. The network messages contain sound file identification information that is transmitted from the sound server across an RS-422 protocol communication line to a serial to Musical Instrument Digital Interface (MIDI) converter. The MIDI converter, in turn relays the sound byte to a sampler, an electronic recording and playback device. The sampler correlates the hexadecimal input to a specific note or stored sound and sends it as an audio signal to speakers via an amplifier. The realism of a simulation is improved by involving multiple participant senses and removing external distractions. This thesis describes the incorporation of sound as aural cues, and the enhancement they provide in the virtual simulation environment of NPSNET. GRA

**N93-18419#** Rensselaer Polytechnic Inst., Troy, NY.
**NEW TECHNIQUES IN OPTICAL COMMUNICATIONS AND SIGNAL PROCESSING Final Report, Aug. 1988 - Apr. 1990**
Pankaj K. Das, Henry Stark, and Nickolas P. Vlannes Dec. 1991 225 p
(Contract F30602-88-D-0025)
(AD-A257894; RL-TR-91-385) Avail: CASI HC A10/MF A03

A synopsis of research in several areas of optical communications and signal processing is provided. The report is divided into sections on spread spectrum techniques in optical communications; optical controller for phased array radar using neural network architectures; two dimensional phased-array optic; hybrid optical/electronic nonlinear optical devices; and image recovery from image plane arrays. Each subject area is treated individually with its own authors, synopsis, and conclusion. A summarization of papers and presentations which resulted from the research effort is provided at the end of the report. GRA

**N93-18580*#** Arizona State Univ., Tempe. Coll. of Engineering and Applied Sciences.
**ADVANCED ELECTROMAGNETIC METHODS FOR AEROSPACE VEHICLES Semiannual Progress Report, 1 Jan. - 30 Jun. 1991**
Constantine A. Balanis, El-Budawy El-Sharawy, Shahrokh Hashemi-Yeganeh, James T. Aberle, and Craig R. Birtcher 30 Jun. 1991 27 p
(Grant NAG1-1082)
(NASA-CR-192180; NAS 1.26:192180) Avail: CASI HC A03/MF A01

During this period the research program addressed the following three topics: (1) composite materials; (2) precipitation static (P-Static); and (3) antenna technology. On the topic of Composite Materials our main efforts were directed toward making measurements on several new samples of composite materials made available to ASU by Stanford Research Institute (SRI) through the efforts of Mr. Frank Casler of AVRADA. These samples can be classified into three distinct materials with each material having its own distinct electrical properties. In addition, attempts were made to make predictions of the effects on antenna patterns by composite materials. This will take a greater emphasis in the next reporting period. In Precipitation Static (P-Static), the main effort was devoted toward developing a Voltage Finite-Difference Time-Domain computer code to account for the voltage variation on a conducting body as the primary source of corona discharge, instead of the electric field. Due to complexities stemming from the interactions between the potentials, the fields, and current sources, the decision was made to begin with a simple two-dimensional problem without the corona discharge and check our programs in a series of simple models, culminating in the full corona discharge problem. This report deals with the first stage of such development. During this reporting period, the main effort in Antenna Technology was toward the design, fabrication, and testing of a cavity-backed slot antenna using ferrite material. Using the ferrite material available to us during this period, the resonances of this antenna were around 5 and 8 GHz. Attempts will be made to model such an antenna and to lower its resonance down into the VHF and UHF bands. Author

**N93-18586*#** Pennsylvania State Univ., University Park. Dept. of Electrical and Computer Engineering.
**FINITE DIFFERENCE TIME DOMAIN MODELING OF SPIRAL ANTENNAS Progress Report, 15 Aug. 1991 - 25 Mar. 1992**
Christopher W. Penney, John H. Beggs, and Raymond J. Luebbers 15 Apr. 1992 9 p
(Grant NAG1-1332)
(NASA-CR-192237; NAS 1.26:192237) Avail: CASI HC A02/MF A01

The objectives outlined in the original proposal for this project were to create a well-documented computer analysis model based on the finite-difference, time-domain (FDTD) method that would be capable of computing antenna impedance, far-zone radiation patterns, and radar cross-section (RCS). The ability to model a variety of penetrable materials in addition to conductors is also desired. The spiral antennas under study by this project meet these requirements since they are constructed of slots cut into conducting surfaces which are backed by dielectric materials. Author

**N93-18598*#** South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences.
**RESEARCH RELATIVE TO WEATHER RADAR MEASUREMENT TECHNIQUES Semiannual Status Report, 15 Nov. 1991 - 15 May 1992**
Paul L. Smith 1992 5 p
(Grant NAG5-1477)
(NASA-CR-191911; NAS 1.26:191911) Avail: CASI HC A01/MF A01

This grant provides for some investigations related to weather radar measurement techniques applicable to meteorological radar systems in Thailand. Quality data are needed from those systems to support TRMM and other scientific investigations. Activities carried out during a trip to the radar facilities at Phuket are described. Author

**N93-18881*#** Nebraska Univ., Lincoln. Dept. of Agricultural Meteorology.
**SLOPE EFFECTS ON SHORTWAVE RADIATION COMPONENTS AND NET RADIATION Progress Report No. 1, 1 Apr. - 31 Dec. 1991**
Elizabeth A. Walter-Shea, Blaine L. Blad, Cynthia J. Hays, and Mark A. Mesarch Jan. 1992 21 p
(Grant NAG5-894)
(NASA-CR-192199; NAS 1.26:192199) Avail: CASI HC A03/MF A01

The main objective of the International Satellite Land Surface Climatology Project (ISLSCP) has been stated as 'the development of techniques that may be applied to satellite observations of the radiation reflected and emitted from the Earth to yield quantitative information concerning land surface climatological conditions.' The major field study, FIFE (the First ISLSCP Field Experiment), was conducted in 1978-89 to accomplish this objective. Four intensive field campaigns (IFC's) were carried out in 1987 and one in 1989. Factors contributing to observed reflected radiation from the FIFE site must be understood before the radiation observed by satellites can be used to quantify surface processes. Analysis since our last report has focused on slope effects on incoming and outgoing shortwave radiation and net radiation from data collected in 1989. Author

**N93-18897*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE TELECOMMUNICATIONS AND DATA ACQUISITION Progress Report, Jul. - Sep. 1992**
Edward C. Posner, ed. 15 Nov. 1992 360 p
(NASA-CR-191998; JPL-TDA-PR-42-111; NAS 1.26:191998) Avail: CASI HC A16/MF A03

This quarterly publication provides archival reports on developments in programs managed by JPL's Office of Telecommunications and Data Acquisition (TDA). In space communications, radio navigation, radio science, and ground-based radio and radar astronomy, it reports on activities of the Deep Space Network (DSN) in planning, supporting research and technology, implementation, and operations. Also included are standards activity at JPL for space data and information systems and reimbursable DSN work performed for other space agencies through NASA. The preceding work is all performed for NASA's Office of Space Communications (OSC). For individual titles, see N93-18898 through N93-18926.

**N93-18898*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SUBNANOSECOND GPS-BASED CLOCK SYNCHRONIZATION AND PRECISION DEEP-SPACE TRACKING** **c04**
C. E. Dunn, S. M. Lichten, D. C. Jefferson, and J. S. Border *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 1-10 (For primary document see N93-18897 06-32)
(RTOP 310-10-61-90-01)
Avail: CASI HC A02/MF A03

Interferometric spacecraft tracking is accomplished by the Deep Space Network (DSN) by comparing the arrival time of electromagnetic spacecraft signals at ground antennas separated by baselines on the order of 8000 km. Clock synchronization errors within and between DSN stations directly impact the attainable tracking accuracy, with a 0.3-nsec error in clock synchronization resulting in an 11-nrad angular position error. This level of synchronization is currently achieved by observing a quasar which is angularly close to the spacecraft just after the spacecraft observations. By determining the differential arrival times of the random quasar signal at the stations, clock offsets and propagation delays within the atmosphere and within the DSN stations are calibrated. Recent developments in time transfer techniques may allow medium accuracy (50-100 nrad) spacecraft tracking without near-simultaneous quasar-based calibrations. Solutions are presented for a worldwide network of Global Positioning System (GPS) receivers in which the formal errors for DSN clock offset parameters are less than 0.5 nsec. Comparisons of clock rate offsets derived from GPS measurements and from very long baseline interferometry (VLBI), as well as the examination of clock closure, suggest that these formal errors are a realistic measure of GPS-based clock offset precision and accuracy. Incorporating GPS-based clock synchronization measurements into a spacecraft differential ranging system would allow tracking without near-simultaneous quasar observations. The impact on individual spacecraft navigation-error sources due to elimination of quasar-based calibrations is presented. System implementation, including calibration of station electronic delays, is discussed. Author

**N93-18899*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PRECISION X-BAND RADIO DOPPLER AND RANGING NAVIGATION: MARS OBSERVER INTERPLANETARY CRUISE SCENARIO** **c13**
J. A. Estefan and S. W. Thurman *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 11-22 (For primary document see N93-18897 06-32)
(RTOP 310-10-63-50)
Avail: CASI HC A03/MF A03

This article describes an error covariance analysis based on a Mars Observer mission scenario; the study was performed to establish the navigation performance that can potentially be achieved in a demonstration of precision two-way X-band (8.4-GHz) Doppler and ranging with the Mars Observer spacecraft planned for next year, and to evaluate the sensitivity of the predicted performance to variations in ground system error modeling assumptions. Orbit determination error statistics computed for a 182-day Doppler and ranging data arc predicted Mars approach orbit determination accuracies of about 0.45 micro-rad in an angular sense, using a conservative ground system error model as a baseline. When less-conservative error model assumptions were employed, it was found that orbit determination accuracies of 0.19 to 0.30 micro-rad could be obtained; the level of accuracy of the assumed Mars ephemeris is about 0.11 micro-rad. In comparison, Doppler-only performance with the baseline error model was predicted to be about 1.30 to 1.51 micro-rad, although it was found that when improved station location accuracies and Global Positioning System-based tropospheric calibration accuracies were assumed, accuracies of 0.44 to 0.52 micro-rad were predicted. In the Doppler plus ranging cases, the results were relatively insensitive to variations in ranging system and station delay calibration uncertainties of a few meters and tropospheric zenith delay calibration uncertainties of a few centimeters. Author

**N93-18900*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SYSTEMS ANALYSIS FOR GROUND-BASED OPTICAL NAVIGATION** **c04**
G. W. Null, W. M. Owen, Jr., and S. P. Synnott *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 23-40 (For primary document see N93-18897 06-32)
(RTOP 310-10-63-55)
Avail: CASI HC A03/MF A03

Deep-space telecommunications systems will eventually operate at visible or near-infrared regions to provide increased information return from interplanetary spacecraft. This would require an onboard laser transponder in place of (or in addition to) the usual microwave transponder, as well as a network of ground-based and/or space-based optical observing stations. This article examines the expected navigation systems to meet these requirements. Special emphasis is given to optical astrometric (angular) measurements of stars, solar system target bodies, and (when available) laser-bearing spacecraft, since these observations can potentially provide the locations of both spacecraft and target bodies. The role of astrometry in the navigation system and the development options for astrometric observing systems are also discussed. Author

**N93-18901*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**STUDY OF NARROW-BAND DICHROIC PLATES WITH CIRCULAR, RECTANGULAR, OR PYLEGUIDE APERTURES**
J. C. Chen *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 41-47 (For primary document see N93-18897 06-32)
(RTOP 310-20-64-86-02)
Avail: CASI HC A02/MF A03

The dichroic plate considered in this article is a metal plate perforated with arrays of apertures such that electromagnetic waves of certain

frequencies pass through the plate and other frequencies are reflected. The shape of the apertures is an important contributor to the performance of the dichroic plate. An S/X dichroic plate, which passes X-band (8.4-8.45 GHz) and reflects S-band (2.0-2.32 GHz), is chosen for a case study. A comparison of the performance of dichroic plates of the same thickness and array pattern is presented for three different aperture shapes: circular, Pyleguide, and rectangular. Author

**N93-18902*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**ANALYSIS AND APPLICATIONS OF A GENERAL BORESIGHT ALGORITHM FOR THE DSS-13 BEAM WAVEGUIDE ANTENNA**
L. S. Alvarez *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 48-61 (For primary document see N93-18897 06-32)
(RTOP 310-20-64-63)
Avail: CASI HC A03/MF A03

A general antenna beam boresight algorithm is presented. Equations for axial pointing error, peak received signal level, and antenna half-power beamwidth are given. A pointing error variance equation is derived that illustrates the dependence of the measurement estimation performance on the various algorithm inputs, including RF signal level uncertainty. Plots showing pointing error uncertainty as function of algorithm inputs are presented. Insight gained from the performance analysis is discussed in terms of its application to the areas of antenna controller and receiver interfacing, pointing error compensation, and antenna calibrations. Current and planned applications of the boresight algorithm, including its role in the upcoming Ka-band downlink experiment (KABLE), are highlighted.
Author

**N93-18903*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**ATMOSPHERIC REFRACTION CORRECTION FOR Ka-BAND BLIND POINTING ON THE DSS-13 BEAM WAVEGUIDE ANTENNA**
I. M. Perez-Borroto and L. S. Alvarez *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 62-70 (For primary document see N93-18897 06-32)
(RTOP 310-20-65-63)
Avail: CASI HC A02/MF A03

An analysis of the atmospheric refraction corrections at the DSS-13 34-m diameter beam waveguide (BWG) antenna for the period Jul. - Dec. 1990 is presented. The current Deep Space Network (DSN) atmospheric refraction model and its sensitivity with respect to sensor accuracy are reviewed. Refraction corrections based on actual atmospheric parameters are compared with the DSS-13 station default corrections for the six-month period. Average blind-pointing improvement during the worst month would have amounted to 5 mdeg at 10 deg elevation using actual surface weather values. This would have resulted in an average gain improvement of 1.1 dB. Author

**N93-18904*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DETERMINATION OF THE DISSIPATIVE LOSS OF A TWO-PORT NETWORK FROM NOISE TEMPERATURE MEASUREMENTS** **c33**
T. Y. Otoshi *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 71-74 (For primary document see N93-18897 06-32)
(RTOP 310-20-65-86-08)
Avail: CASI HC A01/MF A03

When radiometric equipment is available, noise temperature measurement techniques provide a convenient and accurate means for determining the dissipative component of the insertion loss of a two-port network. It is increasingly becoming the practice to ignore mismatch errors caused by multiple reflections between the source, the receiver, and the component whose dissipative loss is being measured. Mismatch errors are difficult to determine in practice because of the requirements of having full knowledge of the magnitudes of reflection coefficients and S-parameters. This article shows it is permissible to neglect the effects of mismatch errors if special conditions are met. These special conditions only require that the reflection coefficients of the source and load be made negligibly small and that the two-port network being evaluated has reciprocal and symmetrical properties. Author

**N93-18905*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SELF-DUAL (48,24;12) CODES** **c64**
G. Solomon *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 75-79 (For primary document see N93-18897 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A01/MF A03

Two self-dual (48,24;12) codes are constructed as 6 x 8 matrices whose columns add up to form an extended BCH-Hamming (8,4;4) code and whose rows sum to odd or even parity. The codes constructed have the identical weight structure of the extended quadratic residue code of length 48. Algebraic isomorphisms may exist between pairs of these three codes. However, because of their matrix form, the newly constructed codes are easily correctable for all five-error and many six-error patterns. The first code comes from restricting a binary cyclic (63,18;36) code to a 6 x 7 matrix and then adjoining six dimensions to the extended 6 x 8 matrix. These six dimensions are generated by linear combinations of row permutations of a 6 x 8 matrix of weight 12, whose sums of rows and columns add to one. The second code comes from a slight modification in the parity (eighth) dimension of the Reed-Solomon (8,4;5) code over GF(64). Error correction in both codes uses the row sum parity information to detect errors in the correction algorithm. Author

**N93-18906*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**MORE BOX CODES** **c64**
G. Solomon *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 80-82 (For primary document see N93-18897 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A01/MF A03

A new investigation shows that, starting from the BCH (21,15;3) code represented as a 7 x 3 matrix and adding a row and column to add even parity, one obtains an 8 x 4 matrix (32,15;8) code. An additional dimension is obtained by specifying odd parity on the rows and even parity on the columns, i.e., adjoining to the 8 x 4 matrix, the matrix, which is zero except for the fourth column (of all ones). Furthermore, any seven rows and three columns will form the BCH (21,15;3) code. This box code has the same weight structure as the quadratic residue and BCH codes of the same dimensions. Whether there exists an algebraic isomorphism to either code is as yet unknown. Author

**N93-18907*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**FAULT DETECTION USING A TWO-MODEL TEST FOR CHANGES IN THE PARAMETERS OF AN AUTOREGRESSIVE TIME SERIES** **c65**
P. Scholtz and P. Smyth *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 83-100 (For primary document see N93-18897 06-32)
(RTOP 310-20-65-91)
Avail: CASI HC A03/MF A03

This article describes an investigation of a statistical hypothesis testing method for detecting changes in the characteristics of an observed time series. The work is motivated by the need for practical automated methods for on-line monitoring of Deep Space Network (DSN) equipment to detect failures and changes in behavior. In particular, on-line monitoring of the motor current in a DSN 34-m beam waveguide (BWG) antenna is used as an example. The algorithm is based on a measure of the information theoretic distance between two autoregressive models: one estimated with data from a dynamic reference window and one estimated with data from a sliding reference window. The Hinkley cumulative sum stopping rule is utilized to detect a change in the mean of this distance measure, corresponding to the detection of a change in the underlying process. The basic theory behind this two-model test is presented, and the problem of practical implementation is addressed, examining windowing methods, model estimation, and detection parameter assignment. Results from the five fault-transition simulations are presented to show the possible limitations of the detection method, and suggestions for future implementation are given. Author

**N93-18908*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**APPLICATION OF MULTIRATE DIGITAL FILTER BANKS TO WIDEBAND ALL-DIGITAL PHASE-LOCKED LOOPS DESIGN** **c33**
R. Sadr, B. Shah, and S. Hinedi *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 101-117 (For primary document see N93-18897 06-32)
(RTOP 310-30-70-92-01)
Avail: CASI HC A03/MF A03

A new class of architecture for all-digital phase-locked loops (DPLL's)

is presented in this article. These architectures, referred to as parallel DPLL (PDPLL), employ multirate digital filter banks (DFB's) to track signals with a lower processing rate than the Nyquist rate, without reducing the input (Nyquist) bandwidth. The PDPLL basically trades complexity for hardware-processing speed by introducing parallel processing in the receiver. It is demonstrated here that the DPLL performance is identical to that of a PDPLL for both steady-state and transient behavior. A test signal with a time-varying Doppler characteristic is used to compare the performance of both the DPLL and the PDPLL. Author

**N93-18909*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**CORRELATED FLUX DENSITIES FROM VLBI OBSERVATIONS WITH THE DSN** **c93**
R. F. Coker *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 118-128 (For primary document see N93-18897 06-32)
(RTOP 314-30-41-11-31)
Avail: CASI HC A03/MF A03

Correlated flux densities of extragalactic radio sources in the very long baseline interferometry (VLBI) astrometric catalog are required for the VLBI tracking of Galileo, Mars Observer, and future missions. A system to produce correlated and total flux density catalogs was developed to meet these requirements. A correlated flux density catalog of 274 sources, accurate to about 20 percent, was derived from more than 5000 DSN VLBI observations at 2.3 GHz (S-band) and 8.4 GHz (X-band) using 43 VLBI radio reference frame experiments during the period 1989-1992. Various consistency checks were carried out to ensure the accuracy of the correlated flux densities. All observations were made on the California-Spain and California-Australia DSN baselines using the Mark 3 wideband data acquisition system. A total flux density catalog, accurate to about 20 percent, with data on 150 sources, was also created. Together, these catalogs can be used to predict source strengths to assist in the scheduling of VLBI tracking passes. In addition, for those sources with sufficient observations, a rough estimate of source structure parameters can be made. Author

**N93-18910*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE EFFECTS OF CORRELATED NOISE IN INTRA-COMPLEX DSN ARRAYS FOR S-BAND GALILEO TELEMETRY RECEPTION** **c17**
R. J. Dewey *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 129-152 (For primary document see N93-18897 06-32)
(RTOP 314-30-61-01-95)
Avail: CASI HC A03/MF A03

A number of the proposals for supporting a Galileo S-band (2.3-GHz) mission involve arraying several antennas to maximize the signal-to-noise ratio (and bit rate) obtainable from a given set of antennas. Arraying is no longer a new idea, having been used successfully during the Voyager encounters with Uranus and Neptune. However, arraying for Galileo's tour of Jupiter is complicated by Jupiter's strong radio emission, which produces correlated noise effects. This article discusses the general problem of correlated noise due to a planet, or other radio source, and applies the results to the specific case of an array of antennas at the DSN's Tidbinbilla, Australia, complex (DSS 42, DSS 43, DSS 45, and the yet-to-be-built DSS 34). The effects of correlated noise are highly dependent on the specific geometry of the array and on the spacecraft-planet configuration; in some cases, correlated noise effects produce an enhancement, rather than a degradation, of the signal-to-noise ratio. For the case considered here--an array of the DSN's Australian antennas observing Galileo and Jupiter--there are three regimes of interest. If the spacecraft-planet separation is approximately less than 75 arcsec, the average effect of correlated noise is a loss of signal to noise (approximately 0.2 dB as the spacecraft-planet separation approaches zero). For spacecraft-planet separations approximately greater than 75 arcsec, but approximately less than 400 arcsec, the effects of correlated noise cause signal-to-noise variations as large as several tenths of a decibel over time scales of hours or changes in spacecraft-planet separation of tens of arcseconds; however, on average its effects are small (less than 0.01 dB). When the spacecraft is more than 400 arcsec from Jupiter (as is the case for about half of Galileo's tour), correlated noise is a less than 0.05-dB effect. Author

**N93-18911*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DEMONSTRATION OF A JOINT US-RUSSIAN VERY LONG BASELINE INTERFEROMETRY TRACKING CAPABILITY** **c17**
P. M. Kroger, B. A. Iijima, C. D. Edwards, V. Altunin (Academy of Sciences, USSR, Moscow ), V. Alexeev (Academy of Sciences, USSR, Moscow ), B. Lipatov (Academy of Sciences, USSR, Moscow ), and E. Molotov (Academy of Sciences, USSR, Moscow ) *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 153-166 (For primary document see N93-18897 06-32)
(RTOP 314-30-61-01-95)
Avail: CASI HC A03/MF A03

This article discusses results of the first very long baseline interferometric (VLBI) measurements between antennas of the NASA DSN and the Russian three-station spacecraft tracking network. The VLBI systems of the U.S. and Russian tracking networks are described, and their compatibility for joint U.S.-Russian measurements is discussed. The results of a series of VLBI measurements involving Deep Space Stations and Russian tracking antennas are presented. The purpose of these first observations is to establish the compatibility of the two VLBI recording systems and verify that data recorded on these systems can be successfully correlated. The delay and delay rate observables produced by correlation of the recorded data are then used to estimate the locations of the Russian tracking stations relative to the Deep Space Stations. These first experiments, carried out at 1.7 GHz, are precursors to a future series of observations at 2 and 8 GHz, which will provide far more accurate station location estimates. The capability of the VLBI systems for joint U.S.-Russian spacecraft navigation measurements is also discussed. Author

**N93-18912*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**ADAPTIVE LOW-BANDWIDTH TRACKING OF GALILEO AND PIONEER 10 CARRIERS**
D. A. Watola *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 167-178 (For primary document see N93-18897 06-32)
(RTOP 314-30-51-01-25)
Avail: CASI HC A03/MF A03

In the Deep Space Network, tracking of residual carrier phase typically occurs with a fixed-bandwidth phase-locked loop using a bandwidth sufficiently wide to prevent loss of lock under worst-case conditions of signal dynamics, received signal phase noise, and receiver phase noise. Much of the time, however, such a high bandwidth is not required and may inflict unnecessarily heavy penalties on loop signal-to-noise ratios. This article describes a technique for improving tracking performance by permitting initial tracking at narrow bandwidths and gradually widening the loop as needed. The cost is a requirement for signal buffering, which is relatively inexpensive for low data rate applications. Results based on off-line processing of recorded carrier data from Galileo and Pioneer 10 are presented, and show potential 10-16 dB gains in loop SNR over worst-case fixed-bandwidth tracking. Author

**N93-18913*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**TRACKING PERFORMANCE AND CYCLE SLIPPING IN THE ALL-DIGITAL SYMBOL SYNCHRONIZER LOOP OF THE BLOCK 5 RECEIVER**
M. Aung *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 179-191 (For primary document see N93-18897 06-32)
(RTOP 310-30-50-10-01)
Avail: CASI HC A03/MF A03

Computer simulated noise performance of the symbol synchronizer loop (SSL) in the Block 5 receiver is compared with the theoretical noise performance. Good agreement is seen at the higher loop SNR's (SNR(sub L)'s), with gradual degradation as the SNR(sub L) is decreased. For the different cases simulated, cycle slipping is observed (within the simulation time of 10(exp 4) seconds) at SNR(sub L)'s below different thresholds, ranging from 6 to 8.5 dB, comparable to that of a classical phase-locked loop. An important point, however, is that to achieve the desired loop SNR above the seemingly low threshold to avoid cycle slipping, a large data-to-loop-noise power ratio, P(sub D)/(N(sub 0)B(sub L)), is necessary (at least 13 dB larger than the desired SNR(sub L) in the optimum case and larger otherwise). This is due to the large squaring loss (greater than or equal to 13 dB) inherent in the SSL. For the special case of symbol rates approximately equaling the loop update rate, a more accurate equivalent model accounting for an extra loop update period delay (characteristic of the SSL phase detector design) is derived. This model results in a more accurate estimation of the noise-equivalent bandwidth of the loop. Author

**N93-18914*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SNR DEGRADATION IN SQUARE-WAVE SUBCARRIER DOWNCONVERSION**
Y. Feria and J. Statman *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 192-201 (For primary document see N93-18897 06-32)
(RTOP 314-30-51-01-25)
Avail: CASI HC A02/MF A03

This article presents a study of signal-to-noise ratio (SNR) degradation in the process of square-wave subcarrier downconversion. The study shows three factors that contribute to the SNR degradation: the cutoff of the higher frequency components in the data, the approximation of a square wave with a finite number of harmonics, and nonideal filtering. Both analytical and simulation results are presented. Author

**N93-18915*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE USE OF SUBCARRIERS IN FUTURE DSN MISSIONS**
M. M. Shihabi, T. M. Nguyen, and S. M. Hinedi *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 202-223 (For primary document see N93-18897 06-32)
(RTOP 314-40-22-70-07)
Avail: CASI HC A03/MF A03

The performance of deep space telemetry signals that employ a residual carrier modulation technique is compared in the presence and absence of a subcarrier. When the subcarrier is present, the performance for the resulting pulse-coded modulation/phase-shift keyed/phase-modulated (PCM/PSK/PM) scheme is evaluated for both sine wave and square wave subcarriers and non-return-to zero (NRZ) data. When the subcarrier is absent, the performance for the resulting PCM/PM technique is evaluated for both the NRZ and the bi-phase data format. The comparison is based on telemetry performance as well as bandwidth efficiency. The first criterion is characterized in terms of the symbol error rate (SER) as a function of symbol SNR, loop bandwidth-to-data rate ratio, and modulation index. The bandwidth efficiency is characterized by the occupancy factor. The results of both the analysis and measurements show that when the interference-to-carrier ratio (ICR) is less than -15 dB, the performance degradation in the absence of a subcarrier is negligible. Various combinations of loop bandwidth-to-data rate ratios and modulation indices that achieve this performance are derived and listed. Bandwidth occupancy comparison indicates that PCM/PM/NRZ is the most efficient in this regard. Therefore, by eliminating the subcarrier and using the PCM/PM/NRZ scheme, many advantages can be realized without any sacrifice in performance. Author

**N93-18916*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**MATHEMATICAL MODELING OF BENT-AXIS HYDRAULIC PISTON MOTORS** **c37**
R. D. Bartos *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 224-235 (For primary document see N93-18897 06-32)
(RTOP 314-30-42-10-87)
Avail: CASI HC A03/MF A03

Each of the DSN 70-m antennas uses 16 bent-axis hydraulic piston motors as part of the antenna drive system. On each of the two antenna axes, four motors are used to drive the antenna and four motors provide counter torque to remove the backlash in the antenna drive train. This article presents a mathematical model for bent-axis hydraulic piston motors. The model was developed to understand the influence of the hydraulic motors on the performance of the DSN 70-m antennas' servo control system. Author

**N93-18917*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**REDUCING THE NET TORQUE AND FLOW RIPPLE EFFECTS OF MULTIPLE HYDRAULIC PISTON MOTOR DRIVES** **c37**
R. D. Bartos *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 236-245 (For primary document see N93-18897 06-32)
(RTOP 314-30-42-10-87)
Avail: CASI HC A02/MF A03

The torque and flow ripple effects which result when multiple hydraulic motors are used to drive a single motion of a mechanical device can significantly affect the way in which the device performs. This article presents a mathematical model describing the torque and flow ripple effects of a bent-axis hydraulic piston motor. The model is used to show how the ripple magnitude can be reduced when multiple motors are used to drive a motion. A discussion of the hydraulic servo system of the 70-m antennas located with the Deep Space Network is included to demonstrate the application of the concepts presented. Author

**N93-18918*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**HELIUM COMPRESSORS FOR CLOSED-CYCLE, 4.5-KELVIN REFRIGERATORS** **c31**
T. R. Hanson *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 246-253 (For primary document see N93-18897 06-32)
(RTOP 310-30-43-10-11)
Avail: CASI HC A02/MF A03

An improved helium compressor for traveling-wave maser and closed-cycle refrigerator systems was developed and is currently being supplied to the DSN. This new 5-hp compressor package is designed to replace the current 3-hp DSN compressors. The new compressor package was designed to retrofit into the existing 3-hp compressor frame and reuse many of the same components, therefore saving the cost of documenting and fabricating these components when implementing a new 5-hp compressor. Author

**N93-18919*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**MINIMIZING NOISE-TEMPERATURE MEASUREMENT ERRORS** **c33**
C. T. Stelzried *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 254-268 (For primary document see N93-18897 06-32)
(RTOP 314-40-31-30-06)
Avail: CASI HC A03/MF A03

An analysis of noise-temperature measurement errors of low-noise amplifiers was performed. Results of this analysis can be used to optimize measurement schemes for minimum errors. For the cases evaluated, the effective noise temperature (Te) of a Ka-band maser can be measured most accurately by switching between an ambient and a 2-K cooled load without an isolation attenuator. A measurement accuracy of 0.3 K was obtained for this example. Author

**N93-18920*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**CORRECTION OF HIGH-FREQUENCY NOISE-TEMPERATURE INACCURACIES** **c33**
C. T. Stelzreid *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 269-277 (For primary document see N93-18897 06-32)
(RTOP 314-40-31-30-06)
Avail: CASI HC A02/MF A03

Deep-space mission data rates to Earth are limited by the system operating noise-temperature (T(sub op)) performance of the DSN. This article addresses some of the techniques and definitions used for measuring and reporting the effective noise temperature of receivers (Te) and T(sub op) of the DSN's ground receiving systems. Calibration loads are used to measure T(sub op) of the DSN antennas. At 32 GHz, a calibration load cooled to 2-K physical temperature requires a correction of 0.67 K to determine the noise temperature. Using corrected noise temperature for the calibration loads results in the correct values for T(sub op) such that the total system noise power can be defined by Pn = kT(sub op) B, as required for DSN telecommunications design control tables. T(sub op) and Te should not be converted to equivalent physical temperatures. Author

**N93-18921*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**FAULT IDENTIFICATION USING MULTIDISCIPLINARY TECHNIQUES AT THE MARS/URANUS STATION ANTENNA SITES** **c43**
D. S. Santo, M. B. Schluter, and R. J. Shlemon *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 278-294 (For primary document see N93-18897 06-32)
(RTOP 314-40-42-20-10)
Avail: CASI HC A03/MF A03

A fault investigation was performed at the Mars and Uranus antenna sites at the Goldstone Deep Space Communications Complex in the Mojave desert. The Mars/Uranus Station consists of two large-diameter reflector antennas used for communication and control of deep-space probes and other missions. The investigation included interpretation of Landsat thematic mapper scenes, side-looking airborne radar transparencies, and both color-infrared and black-and-white aerial photography. Four photolineaments suggestive of previously undocumented faults were identified. Three generally discrete morphostratigraphic alluvial-fan deposits were also recognized and dated using geomorphic and soil stratigraphic techniques. Fourteen trenches

were excavated across the four lineaments; the trenches show that three of the photolineaments coincide with faults. The last displacement of two of the faults occurred between about 12,000 and 35,000 years ago. The third fault was judged to be older than 12,000 years before present (ybp), although uncertainty remains. None of the surface traces of the three faults crosses under existing antennas or structures; however, their potential activity necessitates appropriate seismic retrofit designs and loss-prevention measures to mitigate potential earthquake damage to facilities and structures. Author

**N93-18922*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**A METHOD OF OPTIMAL RADIO FREQUENCY ASSIGNMENT FOR DEEP SPACE MISSIONS**
C. J. Ruggier, J. M. Gevargiz, L. H. Truong, and K. S. Suwitra *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 295-309 (For primary document see N93-18897 06-32)
(RTOP 315-20-50-00-06)
Avail: CASI HC A03/MF A03

A method for determining optimal radio frequency channels for the Deep Space Network is described. Computer automated routines calculate interference-to-signal ratios over a given mission period and provide a quantitative assessment of the channels which could then be assigned to a new mission. This automated procedure reduces the analysis time considerably and effectively improves upon the accuracy of existing channel assignment techniques. Author

**N93-18923*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**A 32-GHz PHASED ARRAY TRANSMIT FEED FOR SPACECRAFT TELECOMMUNICATIONS**
K. A. Lee, D. L. Rascoe, R. A. Crist, J. Huang, P. D. Wamhof, and F. S. Lansing *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 310-324 (For primary document see N93-18897 06-32)
(RTOP 315-91-50-20-02)
Avail: CASI HC A03/MF A03

A 21-element phased array transmit feed was demonstrated as part of an effort to develop and evaluate state-of-the-art transmitter and receiver components at 32 and 34 GHz for future deep-space missions. Antenna pattern measurements demonstrating electronic beam steering of the two-dimensional array are reported and compared with predictions based on measured performance of MMIC-based phase shifter and amplifier modules and Vivaldi slotline radiating elements. Author

**N93-18924*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**A STATISTICAL MODEL FOR EVALUATING GOPEX UPLINK PERFORMANCE**
K. Kiesaleh and T.-Y. Yan *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 325-332 (For primary document see N93-18897 06-32)
(RTOP 315-91-60-10-03)
Avail: CASI HC A02/MF A03

This article describes a statistical model to analyze the signal intensity received at the solid-state imaging (SSI) camera of the Galileo optical communications system from an Earth-based transmitter (GOPEX) demonstration. The analytical model assumes that the optical beam possesses a Gaussian profile and the communication channel has a log-normal scattering characteristic. The atmospheric-induced jitter is modelled as two independent zero mean Gaussian random variables. By modelling the system parameters as a set of independent and identically distributed (iid) random variables, the combined impact of uncertainties due to system parameters and the turbulent atmosphere can be approximated by a log-normal distributed signal intensity at the spacecraft. A Monte-Carlo software simulation package was also developed to compute the confidence interval probabilities for general optical beam profiles. Numerical results show that the approximation is valid for a wide range of operation scenarios. Author

**N93-18925*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**A MODEL TO COMPARE PERFORMANCE OF SPACE AND GROUND NETWORK SUPPORT OF LOW-EARTH ORBITERS**
E. C. Posner *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 333-339 (For primary document see N93-18897 06-32)
(RTOP 055-00-00)
Avail: CASI HC A02/MF A03

This article compares the downlink performance in a gross average sense between space and ground network support of low-Earth orbiters. The purpose is to assess what the demand for DSN support of future small, low-cost missions might be, if data storage for spacecraft becomes reliable enough and small enough to support the storage requirements needed to enable support only a fraction of the time. It is shown that the link advantage of the DSN over space reception in an average sense is enormous for low-Earth orbiters. The much shorter distances needed to communicate with the ground network more than make up for the speedup in data rate needed to compensate for the short contact times with the DSN that low-Earth orbiters have. The result is that more and more requests for DSN-only support of low-Earth orbiters can be expected. Author

**N93-18926*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**AN ANALYSIS OF I/O EFFICIENT ORDER-STATISTIC-BASED TECHNIQUES FOR NOISE POWER ESTIMATION IN THE HRMS SKY SURVEY'S OPERATIONAL SYSTEM** **c33**
G. A. Zimmerman and E. T. Olsen *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 340-351 (For primary document see N93-18897 06-32)
(RTOP 108-30-30-40-04)
Avail: CASI HC A03/MF A03

Noise power estimation in the High-Resolution Microwave Survey (HRMS) sky survey element is considered as an example of a constant false alarm rate (CFAR) signal detection problem. Order-statistic-based noise power estimators for CFAR detection are considered in terms of required estimator accuracy and estimator dynamic range. By limiting the dynamic range of the value to be estimated, the performance of an order-statistic estimator can be achieved by simpler techniques requiring only a single pass of the data. Simple threshold-and-count techniques are examined, and it is shown how several parallel threshold-and-count estimation devices can be used to expand the dynamic range to meet HRMS system requirements with minimal hardware complexity. An input/output (I/O) efficient limited-precision order-statistic estimator with wide but limited dynamic range is also examined. Author

**N93-18954#** Oakland Univ., Rochester, MI. Dept. of Physics.
**AMORPHOUS MAGNETIC INSULATORS FOR MICROWAVE DEVICE APPLICATIONS Final Report, 1 Jan. 1990 - 31 Dec. 1991**
Gopalan Srinivasan 1 Jan. 1992 16 p
(Contract N00014-90-J-1429)
(AD-A259029) Avail: CASI HC A03/MF A01

Results of our studies on thin films of amorphous magnetic oxides are summarized. The main emphasis of the program was on the preparation and magnetic characterization of amorphous BiFeO3 films substituted with nonmagnetic perovskites, zinc ferrite, copper ferrite, and calcium ferrite. Magnetization and ferromagnetic resonance techniques were used to study the magnetic structure in as-sputtered films, the onset of a magnetically ordered state in annealed samples, and the effects of crystallization on magnetic parameters. The main accomplishments of our efforts are: (1) amorphous insulators with the highest saturation magnetization ever achieved were synthesized, (2) anisotropic amorphous magnets were realized in perovskite-spinel systems, and (3) the nature and composition of magnetically ordered clusters that give rise to a spontaneous magnetic moment were identified in some compounds. GRA

**N93-18958#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ETANN HARDWARE IMPLEMENTATION FOR RADAR EMITTER IDENTIFICATION M.S. Thesis**
James B. Calvin, Jr. Dec. 1992 155 p
(AD-A259077; AFIT/GE/ENG/92D-08) Avail: CASI HC A08/MF A02

This study investigated classification of 30 radar emitters with 16 signal features using Intel's 80170NX chip, the Electronically Trainable Analog Neural Network (ETANN). Software tools were developed to characterize the ETANN sigmoidal transfer function for use in a custom simulator, known as Neural Graphics. Neural Graphics operates on a Silicon Graphics workstation. The Intel Neural Network Training System simulators were used in early experiments, but were found to be inefficient in training on data used in this research. Using a modified Neural Graphics simulator,

single chip and multi-chip experiments were performed to provide benchmark results prior to performing chip-in-loop training. By maximizing off-chip training accuracy, the need for on-chip training is minimized; therefore, the device life is prolonged. Several single chip and multi-chip configurations were tried; the final architecture which produced the maximum on-chip classification accuracy was a hierarchical network. The maximum on-chip classification accuracy for a single chip implementation of 30 classes without chip-in-loop training was 83 percent. Again without chip-in-loop training, the maximum on-chip classification accuracy for a hierarchical configuration with the 30-class problem was 87 percent. GRA

**N93-18993#** Centre de Recherches Routieres, Brussels (Belgium).
**BIBLIOGRAPHIC STUDY OF GEORADAR PRINCIPLES, APPLICATIONS, ADVANTAGES, AND INCONVENIENCE [ETUDE BIBLIOGRAPHIQUE SUR LE GEORADAR PRINCIPE, APPLICATIONS, AVANTAGES ET INCONVENIENTS]**
Paul deClerck [1991] 53 p In FRENCH
(CR-35/91) Avail: CASI HC A04/MF A01

Electromagnetic soil surveying has been studied for more than 20 years. The abundant number of references on the subject testifies to the many attempts that have been made to sound the subsurface soil by means of electromagnetic waves. This method has also been used to investigate structures such as tunnel walls and airfield pavements. Electromagnetic waves can be used to examine both soils and structures (bridge decks, tunnel walls, etc.). The possibilities offered by the technique are constantly increased by new developments in electronics and computer science. As a result, large quantities of measuring data and extensive signals processing (including Fourier analysis) are no longer an obstacle to the frequent use of soil-penetrating radar. The road industry too is very interested, with a view to applications such as investigating sites for new road construction, surveying existing road structures or probing for buried conduits or remnants of foundations, which may cause a lot of problems or entail substantial costs when carrying out road works. The literature survey reviews some 25 years of reporting on attempts to use electromagnetic pulses for nondestructive material testing. The applications of the technique were originally of a military nature, but now range from geology, archaeology, environmental management and mining to the investigation of structures, buildings, bridges and roads. The higher the frequency, the higher the resolution and the smaller the depth of penetration. Special antennas are required for specific applications such as the detection of linear structures (pipes, cables) or the investigation of walls and bridge decks. Radar is a fast, high-yield and continuous method of surveying and the waves are not stopped by voids or cracks, unlike acoustic waves or seismic vibrations. Radar operates well in poorly conducting materials and less well in wet or clayey soils. It is a very promising technique besides resistivity, infrared thermography and acoustic sounding. Author

**N93-19000#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**THEORY AND IMPLEMENTATION OF WAVELET ANALYSES IN RATIONAL RESOLUTION DECOMPOSITIONS M.S. Thesis**
Bruce P. Anderson Dec. 1992 162 p
(AD-A259040; AFIT/GE/ENC/92D-1) Avail: CASI HC A08/MF A02

The multiresolution analysis (MRA) developed by Mallat and Meyer and further discussed by Daubechies is a useful tool in the analysis of sampled signals such as images and speech. The theory and implementation of a rational-resolution analysis (RRA) as an extension of the dyadic MRA for arbitrary rational dilation factors is developed. A method to calculate families of compactly-supported scaling functions and wavelets based on arbitrary integer dilation factors is presented and examples provided. The perfect-reconstruction properties of the RRA are discussed and it is demonstrated that the compactly-supported scaling functions and wavelets do not yield perfect-reconstruction. However, the approximation-reconstruction is demonstrated and families of basis function which do lead to perfect reconstruction are characterized. Finally, comparisons are made between RRA's and conventional MRA's and illustrated with speech signals. GRA

**N93-19010#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN ANALYSIS OF USSPACECOM'S SPACE SURVEILLANCE NETWORK SENSOR TASKING METHODOLOGY M.S. Thesis**
Jeff M. Berger, Joseph B. Moles, and David G. Wilsey Dec. 1992 408 p
(AD-A258971; AFIT/GSO/ENG/92D-02) Avail: CASI HC A18/MF A04

This study provides the basis for the development of a cost/benefit assessment model to determine the effects of alterations to the Space Surveillance Network (SSN) on orbital element (OE) set accuracy. It provides a review of current methods used by NORAD and the SSN to gather and process observations, an alternative to the current Gabbard classification method, and the development of a model to determine the effects of observation rate and correction interval on OE set accuracy. The proposed classification scheme is based on satellite J2 perturbations. Specifically, classes were established based on mean motion, eccentricity, and inclination since J2 perturbation effects are functions of only these elements. Model development began by creating representative sensor observations using a highly accurate orbital propagation model. These observations were compared to predicted observations generated using the NORAD Simplified General Perturbation (SGP4) model and differentially corrected using a Bayes, sequential estimation, algorithm. A 10-run Monte Carlo analysis was performed using this model on 12 satellites using 16 different observation rate/correction interval combinations. An ANOVA and confidence interval analysis of the results show that this model does demonstrate the differences in steady state position error based on varying observation rate and correction interval. GRA

**N93-19073#** Mission Research Corp., Albuquerque, NM.
**PORTABLE RF LEAK DETECTOR EVALUATIONS AND UDRI/MRC HAMS REFINEMENTS Interim Report, Apr. - Nov. 1990**
David A. Schafer, Gerald P. Chapman, and Aka G. Finci 7 Jul. 1992 252 p
(AF Proj. 2418)
(AD-A258819; MRC/ABQ-R-1364; UDR-TR-90-126; WL-TR-91-4093)
Avail: CASI HC A12/MF A03

Two tasks related to the detection and measurement of EMI/RFI leaks in electrically shielded portable tactical shelters were carried out. The first task consisted of the evaluation of four portable, hand-held radio frequency (RF) leak detectors ('sniffers'). The evaluation consisted of an assessment of their reliability, ease of operation, battery life, and sensitivity. Their performance was measured on an S250G tactical shelter and compared against MIL-STD-285 test results. The second task consisted of the refinement of a previously developed hardness assurance monitoring system (HAMS). These refinements included further development of the sensor-driven pairs by which EMI leaks are detected and identification of commercial replacement components for custom-built parts in the original prototype unit. This is the first step towards militarization of the design. GRA

**N93-19077#** Aerospace Corp., El Segundo, CA. Engineering and Technology Group.
**PLOTTING THE MAGNITUDE AND DIRECTION OF WAVEGUIDE SURFACE CURRENTS IN THREE DIMENSIONS**
T. J. Peters 30 Sep. 1992 122 p
(Contract F04701-88-C-0089)
(AD-A258872; TR-92(2930)-4; SMC-TR-92-52) Avail: CASI HC A06/MF A02

A method is presented to plot the magnitude and direction of the current induced on the inside surface of a rectangular or circular waveguide. The method requires the geometry of each waveguide to be modeled using a triangular mesh and assumes that the surface current values are known only at the vertices. Since a simple mapping exists between a two-dimensional rectangular region and the surface of a rectangular or circular waveguide, the plotting algorithm is designed to process two-dimensional data and then perform a mapping to a three-dimensional surface. GRA

**N93-19080#** Massachusetts Inst. of Tech., Lexington.
**THE TERMINAL DOPPLER WEATHER RADAR (TDWR) MOVING TARGET SIMULATOR (MTS) AT ORLANDO, FLORIDA**
W. H. Drury and J. M. Frankovich 20 Aug. 1992 19 p
(Contract DTFA-01-89-Z-02033)
(AD-A258885; ATC-188; DOT/FAA/NR-92/4) Avail: CASI HC A03/MF A01

Monitoring the performance of Doppler weather radars presents special

problems since target returns cannot be verified by reference to other systems (e.g., as ASR-9 aircraft reports can be compared with beacon replies). The Terminal Doppler Weather Radar (TDWR) system includes a Moving Target Simulator (MTS) which provides a point target equivalent to a 50 dBZ reflectivity weather return with an apparent radial velocity of 5 m/s. This report describes the installation results for a prototype MTS using the TDWR testbed radar in Orlando, FL. Procedures were developed for improved aiming of the MTS, using aiming of the MTS, using azimuth and elevation adjustments, which are recommended to be incorporated in the production MTS installation procedure. Initial data analyses indicate that the MTS returns from a typical radio tower would be useful for integrity monitoring in fair weather using typical TDWR filters. The use of the MTS when high -reflectivity weather or anomalous propagation (AP) is present needs further study. GRA

**N93-19087#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**LOCATING AN IMAGING RADAR IN CANADA FOR IDENTIFYING SPACEBORNE OBJECTS M.S. Thesis**

William G. Schick Dec. 1992 241 p

(AD-A258969; AFIT/GSO/ENS/92D-13) Avail: CASI HC A11/MF A03

This research presents a study of the maximal coverage p-median facility location problem as applied to the location of an imaging radar in Canada for imaging spaceborne objects. The classical mathematical formulation of the maximal coverage p-median problem is converted into network-flow with side constraint formulations that are developed using a scaled down version of the imaging radar location problem. Two types of network-flow with side constraint formulations are developed: a network using side constraints that simulates the gains in a generalized network; and a network resembling a multi-commodity flow problem that uses side constraints to force flow along identical arcs. These small formulations are expanded to encompass a case study using 12 candidate radar sites, and 48 satellites divided into three states. SAS/OR PROC NETFLOW was used to solve the network-flow with side constraint formulations. The case study show that potential for both formulations, although the simulated gains formulation encountered singular matrix computational difficulties as a result of the very organized nature of its side constraint matrix. The multi-commodity flow formulation, when combined with equi-distribution of flow constraints, provided solutions for various values of p, the number of facilities to be selected. GRA

**N93-19094#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**ACQUISITION OF DIRECT SEQUENCE SPREAD SPECTRUM SIGNALS USING DIGITAL SIGNAL PROCESSING TECHNIQUES M.S. Thesis**

Ronald E. Schmitz Dec. 1992 141 p

(AD-A258974; AFIT/GE/ENG/92D-35) Avail: CASI HC A07/MF A02

This thesis investigates the use of digital signal processing (DSP) techniques to achieve initial synchronization with Global Positioning System (GPS) Pseudo-Noise (PN) signals. Synchronization with the transmitted PN signal is essential to the despreading of the transmitted Direct Sequence Spread Spectrum (DS/SS) signals and decoding of the transmitted satellite data. The use of DSP methods to decrease the time required to achieve initial synchronization is investigated. This thesis proposes an initial acquisition section of the GPS receiver and derives the equations to show the method is mathematically feasible. Computer simulations of the proposed receiver using received signals corrupted by Doppler shifts and noise and having various code offsets, show that coarse acquisition of GPS signals can be achieved using DSP methods. However, the correlation of the sequences is distorted by zero padding to allow the use of radix-2 FFT's. This distortion can be accounted for and proper coarse acquisition is still achieved. GRA

**N93-19099#** Defence Research Establishment, Ottawa (Ontario).

**DESCRIPTION OF A DATA ACQUISITION SYSTEM FOR THE MEASUREMENTS OF EMP TRANSIENT FIELDS**

Marc Dion Mar. 1992 44 p

(AD-A259013; DREO-TN-92-7) Avail: CASI HC A03/MF A01

This technical note describes a data acquisition system developed at DREO for the measurements of very fast transient electromagnetic fields generated during EMP testing. The system consists of several high speed transient digitizers, all connected to a personal computer. It has the capability to simultaneously record on several channels the response of single-shot events. The overall system is controlled by a master program called DAQ. DAQ can control a number of digitizers simultaneously, allowing automation of part of the measurement process. The data transferred to the PC is automatically bound with related information such as: experiment description, setup information (sensor, cable, attenuator, and instrument used), digitizer parameters, and data processing. DAQ can archive and retrieve the results of a large number of experiments. DAQ can produce plots of the results on the screen or on hardcopy, and also has the capability to import the plots into popular word processors for the preparation of reports. DAQ incorporates several digital signal processing routines, which may be used to process the raw data. Various implementations of Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters are supported, as well as some of the classical approaches such as Butterworth low-pass and hi-pass filters. GRA

**N93-19100#** Defence Research Establishment, Ottawa (Ontario).

**ADVANCED COMMUNICATION ESM SYSTEM (ACES) DESIGN CONSIDERATIONS**

Derek Elsaesser and Brian Kozminchuk Dec. 1991 37 p

(AD-A259014; DREO-TN-92-2) Avail: CASI HC A03/MF A01

This note outlines the proposed design and development of the Advanced Communication ESM System (ACES) testbed in the Communication Electronic Warfare (CEW) Section at DREO. The purpose of this testbed is to develop a high Probability of Intercept (POI) ESM system for use against various conventional and exotic HF and VHF communications signals. This work is being carried out in support of the army (D-Sigs-EM2) under Task 041XG. The ACES testbed will use wideband digital receivers and advanced digital signal processors to provide high POI, real-time signal detection and identification, high resolution DF, data fusion, analysis, and C3I functions. The aim is to produce a complete ESM system suitable for field trials in a real signal environment by March 1994. GRA

**N93-19341#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**RADAR CROSS SECTION MODELS FOR LIMITED ASPECT ANGLE WINDOWS M.S. Thesis**

Mark C. Robinson Dec. 1992 130 p

(AD-A258918; AFIT/GE/ENG/92D-32) Avail: CASI HC A07/MF A02

This thesis presents a method for building Radar Cross Section (RCS) models of aircraft based on static data taken from limited aspect angle windows. These models statistically characterize static RCS. This is done to show that a limited number of samples can be used to effectively characterize static aircraft RCS. The optimum models are determined by performing both a Kolmogorov and a Chi-Square goodness-of-fit test comparing the static RCS data with a variety of probability density functions (pdf) that are known to be effective at approximating the static RCS of aircraft. The optimum parameter estimator is also determined by the goodness of-fit tests if there is a difference in pdf parameters obtained by the Maximum Likelihood Estimator (MLE) and the Method of Moments (MoM) estimators. GRA

**N93-19349#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A TWO-DIMENSIONAL PARTICLE SIMULATION OF PARALLEL PLATE RADIO-FREQUENCY (RF) GLOW DISCHARGES M.S. Thesis**

Eric J. Bennett 1 Dec. 1992 124 p

(AD-A258856; AFIT/GEP/ENP/92D-1) Avail: CASI HC A06/MF A02

A two-dimensional model of parallel plate RF glow discharges was developed to study discharge phenomena important in plasma assisted processing of materials. The particle-in-cell method is used to calculate the trajectories of computer particles under the influence of both self and applied fields. Monte Carlo methods using the null collision technique are used to model collisions between charged particles and neutral gas atoms. Results of computer experiments are presented with special emphasis placed on ion motion in the sheath regions. Experimental results show some qualitative agreement with one-dimensional model results. Further work required to gain quantitative agreement is outlined. GRA

**N93-19368#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**DIGITAL SIGNAL PROCESSING USING LAPPED TRANSFORMS WITH VARIABLE PARAMETER WINDOWS AND ORTHONORMAL BASES M.S. Thesis**

Brian D. Raduenz Dec. 1992 110 p

(AD-A258853; AFIT/GE/ENG/92D-30) Avail: CASI HC A06/MF A02

A number of new concepts and tools for the analysis of signals using variable overlapped windows and orthonormal bases are developed and evaluated. Windowing, often employed as a spectral estimation technique, can result in irreparable distortions in the transformed signal. By placing conditions on the window and incorporating it into the orthonormal representation, any signal distortion resulting from the transformation can be eliminated or cancelled in reconstruction. This concept is critical to the theory discussed. As part of this evaluation, a tensor product based general N-point fast Fourier transform algorithm was implemented in the DOD standard language, Ada. The most prevalent criticism of Ada is slow execution time. This code is shown to be comparable in execution time performance to the corresponding FORTRAN code. Also, a new paradigm is presented for solving the finite length data problem associated with filter banks and lapped transforms. This result could have significant importance in many Air Force applications, such as processing images in which the objects of interest are near the borders. Additionally, a limited number of experiments were performed with the coding of speech. The results indicate the lapped transform evaluated has potential as a low bit rate speech coder. GRA

**N93-19413*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**THE TELECOMMUNICATIONS AND DATA ACQUISITION REPORT Progress Report, Apr. - Jun. 1992**

E. C. Posner, ed. 15 Aug. 1992 290 p

(NASA-CR-191228; JPL-TDA-PR-42-110; NAS 1.26:191228) Avail: CASI HC A13/MF A03

Archival reports on developments in programs managed by JPL's Office of Telecommunications and Data Acquisition (TDA) are provided. In space communications, radio navigation, radio science, and ground-based radio and radar astronomy, it reports on activities of the Deep Space Network (DSN) in planning, in supporting research and technology, in implementation, and in operations. Also included is standards activity at JPL for space data and information. In the search for extraterrestrial intelligence (SETI), the TDA Progress Report reports on implementation and operations for searching the microwave spectrum. Topics covered include tracking and ground-based navigation; communications, spacecraft-ground; station control and system technology; capabilities for new projects; network upgrade and sustaining; network operations and operations support; and TDA program management and analysis. For individual titles, see N93-19414 through N93-19436.

**N93-19414*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.

**PRECISE TRACKING OF THE MAGELLAN AND PIONEER VENUSORBITERS BY SAME-BEAM INTERFEROMETRY. PART 1: DATAACCURACY ANALYSIS** **c13**

J. S. Border, W. M. Folkner, R. D. Kahn, and K. S. Zukor *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 1-20 (For primary document see N93-19413 06-32)

(RTOP 310-10-60-91-01)

Avail: CASI HC A03/MF A03

Simultaneous tracking of two spacecraft in orbit about a distant planet by two widely separated Earth-based radio antennas provides more-accurate positioning information than can be obtained by tracking each spacecraft separately. A demonstration of this tracking technique, referred to as same-beam interferometry (SBI), is currently being done using the Magellan and Pioneer 12 orbiters at Venus. Signals from both spacecraft fall within the same beamwidth of the Deep Space Station antennas. The plane-of-sky position difference between spacecraft is precisely determined by doubly differenced phase measurements. This radio metric measurement naturally complements line-of-sight Doppler. Data was first collected from Magellan and Pioneer 12 on August 11-12, 1990, shortly after Magellan was inserted into Venus orbit. Data were subsequently acquired in February and April 1991, providing a total of 34 hours of same-beam radio metric observables. Same-beam radio metric residuals have been analyzed and compared with model measurement error predictions. The predicted error is dominated by solar plasma fluctuations. The rms of the residuals is less than predicted by about 25 percent for 5-min averages. The shape of the spectrum computed from residuals is consistent with that derived from a model of solar plasma fluctuations. This data type can greatly aid navigation of a second spacecraft when the first is well-known in its orbit. Author

**N93-19415*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Navigation Systems Section.

**APPLICATION OF HIGH-PRECISION TWO-WAY RANGING TO GALILEO EARTH-1 ENCOUNTER NAVIGATION** **c13**

V. M. Pollmeier and S. W. Thurman *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 21-32 (For primary document see N93-19413 06-32)

(RTOP 310-10-63-84-02)

Avail: CASI HC A03/MF A03

The application of precision two-way ranging to orbit determination with relatively short data arcs is investigated for the Galileo spacecraft's approach to its first Earth encounter (December 8, 1990). Analysis of previous S-band (2.3-GHz) ranging data acquired from Galileo indicated that under good signal conditions submeter precision and 10-m ranging accuracy were achieved. It is shown that ranging data of sufficient accuracy, when acquired from multiple stations, can sense the geocentric angular position of a distant spacecraft. A range data filtering technique, in which explicit modeling of range measurement bias parameters for each station pass is utilized, is shown to largely remove the systematic ground system calibration errors and transmission media effects from the Galileo range measurements, which would otherwise corrupt the angle-finding capabilities of the data. The accuracy of the Galileo orbit solutions obtained with S-band Doppler and precision ranging were found to be consistent with simple theoretical calculations, which predicted that angular accuracies of 0.26-0.34 microrad were achievable. In addition, the navigation accuracy achieved with precision ranging was marginally better than that obtained using delta-differenced one-way range (delta DOR), the principal data type that was previously used to obtain spacecraft angular position measurements operationally. Author

**N93-19416*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.

**THE EFFECT OF TROPOSPHERIC FLUCTUATIONS ON THE ACCURACY OF WATER VAPOR RADIOMETRY** **c46**

J. Z. Wilcox *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 33-51 (For primary document see N93-19413 06-32)

(RTOP 310-10-60-86-02)

Avail: CASI HC A03/MF A03

Line-of-sight path delay calibration accuracies of 1 mm are needed to improve both angular and Doppler tracking capabilities. Fluctuations in the refractivity of tropospheric water vapor limit the present accuracies to about 1 nrad for the angular position and to a delay rate of 3x10(exp -13) sec/sec over a 100-sec time interval for Doppler tracking. This article describes progress in evaluating the limitations of the technique of water vapor radiometry at the 1-mm level. The two effects evaluated here are: (1) errors arising from tip-curve calibration of WVR's in the presence of tropospheric fluctuations and (2) errors due to the use of nonzero beamwidths for water vapor radiometer (WVR) horns. The error caused by tropospheric water vapor fluctuations during instrument calibration from a single tip curve is 0.26 percent in the estimated gain for a tip-curve duration of several minutes or less. This gain error causes a 3-mm bias and a 1-mm scale factor error in the estimated path delay at a 10-deg elevation per 1 g/cm(sup 2) of zenith water vapor column density present in the troposphere during the astrometric observation. The error caused by WVR beam averaging of tropospheric fluctuations is 3 mm at a 10-deg elevation per 1 g/cm(sup 2) of zenith water vapor (and is proportionally higher for higher water vapor content) for current WVR beamwidths (full width at half maximum of approximately 6 deg). This is a stochastic error (which cannot be calibrated) and which can be reduced to about half of its instantaneous value by time averaging the radio signal over several minutes. The results presented here suggest two improvements to WVR design: first, the gain of the instruments should be stabilized to 4 parts in 10(exp 4) over a calibration period lasting 5 hours, and second, the WVR antenna beamwidth should be reduced to about 0.2 deg. This will reduce the error induced by

water vapor fluctuations in the estimated path delays to less than 1 mm for the elevation range from zenith to 6 deg for most observation weather conditions. Author

**N93-19417*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.

**THE GOLDSTONE REAL-TIME CONNECTED ELEMENT INTERFEROMETER**

C. Edwards, Jr., D. Rogstad, D. Fort, L. White, and B. Iijima *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 52-62 (For primary document see N93-19413 06-32)

(RTOP 310-10-63-88-01)

Avail: CASI HC A03/MF A03

Connected element interferometry (CEI) is a technique of observing a celestial radio source at two spatially separated antennas and then interfering the received signals to extract the relative phase of the signal at the two antennas. The high precision of the resulting phase delay data type can provide an accurate determination of the angular position of the radio source relative to the baseline vector between the two stations. This article describes a recently developed connected element interferometer on a 21-km baseline between two antennas at the Deep Space Network's Goldstone, California, tracking complex. Fiber-optic links are used to transmit the data to a common site for processing. The system incorporates a real-time correlator to process these data in real time. The architecture of the system is described, and observational data are presented to characterize the potential performance of such a system. The real-time processing capability offers potential advantages in terms of increased reliability and improved delivery of navigational data for time-critical operations. Angular accuracies of 50-100 nrad are achievable on this baseline. Author

**N93-19418*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.

**SPACECRAFT-SPACECRAFT VERY LONG BASELINE INTERFEROMETRY. PART 1: ERROR MODELING AND OBSERVABLE ACCURACY**

C. D. Edwards, Jr. and J. S. Border *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 63-76 (For primary document see N93-19413 06-32)

(RTOP 310-10-60-91-01)

Avail: CASI HC A03/MF A03

In Part 1 of this two-part article, an error budget is presented for Earth-based delta differential one-way range (delta DOR) measurements between two spacecraft. Such observations, made between a planetary orbiter (or lander) and another spacecraft approaching that planet, would provide a powerful target-relative angular tracking data type for approach navigation. Accuracies of better than 5 nrad should be possible for a pair of spacecraft with 8.4-GHz downlinks, incorporating 40-MHz DOR tone spacings, while accuracies approaching 1 nrad will be possible if the spacecraft incorporate 32-GHz downlinks with DOR tone spacing on the order of 250 MHz; these accuracies will be available for the last few weeks or months of planetary approach for typical Earth-Mars trajectories. Operational advantages of this data type are discussed, and ground system requirements needed to enable spacecraft-spacecraft delta DOR observations are outlined. This tracking technique could be demonstrated during the final approach phase of the Mars '94 mission, using Mars Observer as the in-orbit reference spacecraft, if the Russian spacecraft includes an 8.4-GHz downlink incorporating DOR tones. Part 2 of this article will present an analysis of predicted targeting accuracy for this scenario. Author

**N93-19419*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Navigation Systems Section.

**USE OF THE VLBI DELAY OBSERVABLE FOR ORBIT DETERMINATION OF EARTH-ORBITING VLBI SATELLITES** **c13**

J. S. Ulvestad *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 77-91 (For primary document see N93-19413 06-32)

(RTOP 310-10-63-50-00)

Avail: CASI HC A03/MF A03

Very long-baseline interferometry (VLBI) observations using a radio telescope in Earth orbit were performed first in the 1980s. Two spacecraft dedicated to VLBI are scheduled for launch in 1995; the primary scientific goals of these missions will be astrophysical in nature. This article addresses the use of space VLBI delay data for the additional purpose of improving the orbit determination of the Earth-orbiting spacecraft. In an idealized case of quasi-simultaneous observations of three radio sources in orthogonal directions, analytical expressions are found for the instantaneous spacecraft position and its error. The typical position error is at least as large as the distance corresponding to the delay measurement accuracy but can be much greater for some geometries. A number of practical considerations, such as system noise and imperfect calibrations, set bounds on the orbit-determination accuracy realistically achievable using space VLBI delay data. These effects limit the spacecraft position accuracy to at least 35 cm (and probably 3 m or more) for the first generation of dedicated space VLBI experiments. Even a 35-cm orbital accuracy would fail to provide global VLBI astrometry as accurate as ground-only VLBI. Recommended charges in future space VLBI missions are unlikely to make space VLBI competitive with ground-only VLBI in global astrometric measurements. Author

**N93-19420*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.

**MODELING THE GLOBAL POSITIONING SYSTEM SIGNAL PROPAGATION THROUGH THE IONOSPHERE** **c04**

S. Bassiri (Sharif Univ. of Technology, Tehran, Iran ) and G. A. Hajj *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 92-103 (For primary document see N93-19413 06-32)

(RTOP 310-10-61-84-02)

Avail: CASI HC A03/MF A03

Based on realistic modeling of the electron density of the ionosphere and using a dipole moment approximation for the Earth's magnetic field, one is able to estimate the effect of the ionosphere on the Global Positioning System (GPS) signal for a ground user. The lowest order effect, which is on the order of 0.1-100 m of group delay, is subtracted out by forming a linear combination of the dual frequencies of the GPS signal. One is left with second- and third-order effects that are estimated typically to be approximately 0-2 cm and approximately 0-2 mm at zenith, respectively, depending on the geographical location, the time of day, the time of year, the solar cycle, and the relative geometry of the magnetic field and the line of sight. Given the total electron content along a line of sight, the authors derive an approximation to the second-order term which is accurate to approximately 90 percent within the magnetic dipole moment model; this approximation can be used to reduce the second-order term to the millimeter level, thus potentially improving precise positioning in space and on the ground. The induced group delay, or phase advance, due to second- and third-order effects is examined for two ground receivers located at equatorial and mid-latitude regions tracking several GPS satellites. Author

**N93-19421*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.

**EVALUATION OF THE TABLE MOUNTAIN RONCHI TELESCOPE FOR ANGULAR TRACKING** **c89**

G. Lanyi, G. Purcell, R. Treuhaft, and A. Buffington (California Univ., San Diego.) *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 104-117 (For primary document see N93-19413 06-32)

(RTOP 310-10-60-90-03)

Avail: CASI HC A03/MF A03

The performance of the University of California at San Diego (UCSD) Table Mountain telescope was evaluated to determine the potential of such an instrument for optical angular tracking. This telescope uses a Ronchi ruling to measure differential positions of stars at the meridian. The Ronchi technique is summarized and the operational features of the Table Mountain instrument are described. Results from an analytic model, simulations, and actual data are presented that characterize the telescope's current performance. For a star pair of visual magnitude 7, the differential uncertainty of a 5-min observation is about 50 nrad (10 marcsec), and tropospheric fluctuations are the dominant error source. At magnitude 11, the current differential uncertainty is approximately 800 nrad (approximately 170 marcsec). This magnitude is equivalent to that of a 2-W laser with a 0.4-m aperture transmitting to Earth from a spacecraft at Saturn. Photoelectron noise is the dominant error source for stars of visual magnitude 8.5 and fainter. If the photoelectron noise is reduced, ultimately tropospheric fluctuations will be the limiting source of error at an average level of 35 nrad (7 marcsec) for stars approximately 0.25 deg apart. Three near-term strategies are proposed for improving the performance of the telescope to

the 10-nrad level: improving the efficiency of the optics, masking background starlight, and averaging tropospheric fluctuations over multiple observations. Author

**N93-19422*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Navigation Systems Section.

**DEEP-SPACE NAVIGATION APPLICATIONS OF IMPROVED GROUND-BASED OPTICAL ASTROMETRY** **c89**

G. W. Null, W. M. Owen, Jr., and S. P. Synnott *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 118-127 (For primary document see N93-19413 06-32)

(RTOP 310-10-63-55-00)

Avail: CASI HC A02/MF A03

Improvements in ground-based optical astrometry will eventually be required for navigation of interplanetary spacecraft when these spacecraft communicate at optical wavelengths. Although such spacecraft may be some years off, preliminary versions of the astrometric technology can also be used to obtain navigational improvements for the Galileo and Cassini missions. This article describes a technology-development and observational program to accomplish this, including a cooperative effort with U.S. Naval Observatory Flagstaff Station. For Galileo, Earth-based astrometry of Jupiter's Galilean satellites may improve their ephemeris accuracy by a factor of 3 to 6. This would reduce the requirements for onboard optical navigation pictures, so that more of the data transmission capability (currently limited by high-gain antenna deployment problems) can be used for science data. Also, observations of European Space Agency (ESA) Hipparcos stars with asteroid 243 Ida may provide significantly improved navigation accuracy for a planned August 1993 Galileo spacecraft encounter. Author

**N93-19423*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Ground Antennas and Facilities Engineering Section.

**A METHOD FOR MODELING DISCONTINUITIES IN A MICROWAVE COAXIAL TRANSMISSION LINE**

T. Y. Otoshi *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 128-150 (For primary document see N93-19413 06-32)

(RTOP 310-20-65-86-08)

Avail: CASI HC A03/MF A03

A method for modeling discontinuities in a coaxial transmission line is presented. The methodology involves the use of a nonlinear least-squares fit program to optimize the fit between theoretical data (from the model) and experimental data. When this method was applied to modeling discontinuities in a slightly damaged Galileo spacecraft S-band (2.295-GHz) antenna cable, excellent agreement between theory and experiment was obtained over a frequency range of 1.70-2.85 GHz. The same technique can be applied for diagnostics and locating unknown discontinuities in other types of microwave transmission lines, such as rectangular, circular, and beam waveguides. Author

**N93-19424*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Ground Antennas and Facilities Engineering Section.

**DSS-13 BEAM WAVEGUIDE ANTENNA FREQUENCY STABILITY**

T. Y. Otoshi and M. M. Franco *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 151-162 (For primary document see N93-19413 06-32)

(RTOP 310-20-65-92-01)

Avail: CASI HC A03/MF A03

Measurements made on the frequency stability of the DSS-13 34-m diameter Beam Waveguide (BWG) antenna showed that at 46.5 and 37 deg elevation angles, the BWG antenna stability at 12.2 GHz was between 1.3 and 2.2 x 10(exp -15) for tau = 1024 sec and good weather conditions. These frequency stability values apply to the portion of the antenna that includes the main reflector, subreflector, tripod legs, and the six BWG mirrors. The test results reported are believed to be the first known successful measurements of the stability of the microwave optics portion of a large antenna to a level of 1 or 2 parts in 10(exp 15). Author

**N93-19425*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.

**LOCALLY ADAPTIVE VECTOR QUANTIZATION: DATA COMPRESSION WITH FEATURE PRESERVATION** **c61**

K. M. Cheung and M. Sayano (California Inst. of Tech., Pasadena.) *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 163-178 (For primary document see N93-19413 06-32)

(RTOP 310-30-71-83-02)

Avail: CASI HC A03/MF A03

A study of a locally adaptive vector quantization (LAVQ) algorithm for data compression is presented. This algorithm provides high-speed one-pass compression and is fully adaptable to any data source and does not require a priori knowledge of the source statistics. Therefore, LAVQ is a universal data compression algorithm. The basic algorithm and several modifications to improve performance are discussed. These modifications are nonlinear quantization, coarse quantization of the codebook, and lossless compression of the output. Performance of LAVQ on various images using irreversible (lossy) coding is comparable to that of the Linde-Buzo-Gray algorithm, but LAVQ has a much higher speed; thus this algorithm has potential for real-time video compression. Unlike most other image compression algorithms, LAVQ preserves fine detail in images. LAVQ's performance as a lossless data compression algorithm is comparable to that of Lempel-Ziv-based algorithms, but LAVQ uses far less memory during the coding process. Author

**N93-19426*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.

**DATA COMPRESSION BY WAVELET TRANSFORMS** **c61**

M. Shahshahani *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 179-187 (For primary document see N93-19413 06-32)

(RTOP 310-30-71-83-02)

Avail: CASI HC A02/MF A03

A wavelet transform algorithm is applied to image compression. It is observed that the algorithm does not suffer from the blockiness characteristic of the DCT-based algorithms at compression ratios exceeding 25:1, but the edges do not appear as sharp as they do with the latter method. Some suggestions for the improved performance of the wavelet transform method are presented. Author

**N93-19427*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.

**MAXIMAL CODEWORD LENGTHS IN HUFFMAN CODES** **c61**

Y. S. Abu-Mostafa (California Inst. of Tech., Pasadena.) and R. J. McEliece *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 188-193 (For primary document see N93-19413 06-32)

(RTOP 310-30-71-83-02)

Avail: CASI HC A02/MF A03

The following question about Huffman coding, which is an important technique for compressing data from a discrete source, is considered. If p is the smallest source probability, how long, in terms of p, can the longest Huffman codeword be? It is shown that if p is in the range 0 less than p less than or equal to 1/2, and if K is the unique index such that 1/F(sub K+3) less than p less than or equal to 1/F(sub K+2), where F(sub K) denotes the Kth Fibonacci number, then the longest Huffman codeword for a source whose least probability is p is at most K, and no better bound is possible. Asymptotically, this implies the surprising fact that for small values of p, a Huffman code's longest codeword can be as much as 44 percent larger than that of the corresponding Shannon code. Author

**N93-19428*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.

**COMPARISONS OF THEORETICAL LIMITS FOR SOURCE CODING WITH PRACTICAL COMPRESSION ALGORITHMS** **c61**

F. Pollara and S. Dolinar *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 194-201 (For primary document see N93-19413 06-32)

(RTOP 310-30-71-83-02)

Avail: CASI HC A02/MF A03

The performance achieved by some specific data compression algorithms is compared with absolute limits prescribed by rate distortion theory for Gaussian sources under the mean square error distortion criterion. These results show the gains available from source coding and can be used as a reference for the evaluation of future compression schemes. Some current schemes perform well, but there is still room for improvement. Author

**N93-19429*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.

**CASCADED CONVOLUTIONAL CODES** **c17**

F. Pollara and D. Divsalar *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 202-207 (For primary document see N93-19413 06-32)

(RTOP 310-30-71-83-02)

Avail: CASI HC A02/MF A03

Due to the hardware design of Galileo's Command and Data Subsystem (CDS), the channel code usable in an S-band (2290-2300 MHz) mission must include the NASA standard (7,1/2) convolutional code. Galileo's hardware encoder for the (15,1/4) code is not usable in S-band mode. However, the need for higher coding gain dictates the use of long constraint length convolutional codes. Theoretical results show how a large subclass of such codes is realizable by using a software encoder in the CDS cascaded with the hardware encoder for the NASA standard code.

Author

**N93-19430*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.

**BINARY WEIGHT DISTRIBUTIONS OF SOME REED-SOLOMON CODES** **c61**

F. Pollara and S. Arnold *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 208-215 (For primary document see N93-19413 06-32)

(RTOP 310-30-71-83-04)

Avail: CASI HC A02/MF A03

The binary weight distributions of the (7,5) and (15,9) Reed-Solomon (RS) codes and their duals are computed using the MacWilliams identities. Several mappings of symbols to bits are considered and those offering the largest binary minimum distance are found. These results are then used to compute bounds on the soft-decoding performance of these codes in the presence of additive Gaussian noise. These bounds are useful for finding large binary block codes with good performance and for verifying the performance obtained by specific soft-coding algorithms presently under development.

Author

**N93-19431*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Telecommunications Systems Section.

**MULTIPLE SYMBOL PARTIALLY COHERENT DETECTION OF MPSK**

M. K. Simon and D. Divsalar *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 216-230 (For primary document see N93-19413 06-32)

(RTOP 310-30-71-86-99)

Avail: CASI HC A03/MF A03

It is shown that by using the known (or estimated) value of carrier tracking loop signal to noise ratio (SNR) in the decision metric, it is possible to improve the error probability performance of a partially coherent multiple phase-shift-keying (MPSK) system relative to that corresponding to the commonly used ideal coherent decision rule. Using a maximum-likeihood approach, an optimum decision metric is derived and shown to take the form of a weighted sum of the ideal coherent decision metric (i.e., correlation) and the noncoherent decision metric which is optimum for differential detection of MPSK. The performance of a receiver based on this optimum decision rule is derived and shown to provide continued improvement with increasing length of observation interval (data symbol sequence length). Unfortunately, increasing the observation length does not eliminate the error floor associated with the finite loop SNR. Nevertheless, in the limit of infinite observation length, the average error probability performance approaches the algebraic sum of the error floor and the performance of ideal coherent detection, i.e., at any error probability above the error floor, there is no degradation due to the partial coherence. It is shown that this limiting behavior is virtually achievable with practical size observation lengths. Furthermore, the performance is quite insensitive to mismatch between the estimate of loop SNR (e.g., obtained from measurement) fed to the decision metric and its true value. These results may be of use in low-cost Earth-orbiting or deep-space missions employing coded modulations.

Author

**N93-19432*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Ground Antennas and Facilities Engineering Section.

**PARAMETER AND CONFIGURATION STUDY OF THE DSS-13 ANTENNA DRIVES**

W. Gawronski and J. A. Mellstrom *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 231-245 (For primary document see N93-19413 06-32)

(RTOP 310-40-41-10-15)

Avail: CASI HC A03/MF A03

The effects of different elevation and azimuth drive configurations on DSS-13 antenna performance are presented as well as a study of gearbox stiffness and motor inertia. Small motor inertia and rigid gearboxes would improve the pointing accuracy up to a certain limit. The limit is imposed by critical values of gearbox stiffness and motor inertia introduced in the article. The critical values depend on the lowest structural frequency of the rate-loop model. The tracking performance can be improved by raising gearbox stiffness to the critical stiffness and reducing motor inertia to the critical inertia. An azimuth drive configuration with four driven wheels was also investigated. For the four-wheel drive configuration in azimuth, the cross-coupling effects are reduced and wind disturbance rejection properties improved. Pointing is improved substantially in the cross-elevation but is relatively unaffected in the elevation direction. More significant improvements can be achieved through either structural redesign (stiffening the structure) or new control algorithms or control concepts, which would eliminate the effect of flexible deformations on the antenna pointing accuracy. Although the study is performed for the DSS-13 antenna, the results can be extended for other DSN antennas.

Author

**N93-19433*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Ground Antennas and Facilities Engineering Section.

**SETI LOW-FREQUENCY FEED DESIGN STUDY FOR DSS 24**

P. H. Stanton and P. R. Lee *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 246-252 (For primary document see N93-19413 06-32)

(RTOP 314-30-69-40-06)

Avail: CASI HC A02/MF A03

The Search for Extraterrestrial Intelligence Sky Survey project requires operation from 1 to 10 GHz on the beam waveguide (BWG) antenna DSS 24. The BWG reflectors are undersized in the 1- to 3.02-GHz range, resulting in poor performance. Horn designs and a method for implementing 1- to 3.02-GHz operation on DSS 24 are presented. A combination of a horn and a shaped feed reflector placed above the main reflector is suggested. The horn and feed reflector could be hidden in the RF shadow of the subreflector and struts. Results from computer analysis of this design indicate that adequate performance could be achieved.

Author

**N93-19434*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Ground Antennas and Facilities Engineering Section.

**FEED-FORWARD CONTROL UPGRADE OF THE DEEP SPACE NETWORK ANTENNAS**

W. Gawronski *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 253-262 (For primary document see N93-19413 06-32)

(RTOP 644-11-00-06-13)

Avail: CASI HC A02/MF A03

In order to improve the accuracy of high-rate tracking of NASA's DSN antennas, the position-loop controller has been upgraded with a feed-forward loop. Conditions for perfect and approximate tracking with the feed-forward loop are presented. The feed-forward loop improves tracking performance and preserves wind disturbance rejection properties of the previous closed-loop system.

Author

**N93-19435*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. TDA Mission Support and DSN Operations.

**AVAILABILITY ANALYSIS OF THE TRAVELING-WAVE MASER AMPLIFIERS IN THE DEEP SPACE NETWORK. PART 1: THE 70-METER ANTENNAS** **c36**

T. N. Issa *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 263-277 (For primary document see N93-19413 06-32)

(RTOP 314-40-21-30-02)

Avail: CASI HC A03/MF A03

The results of the reliability and availability analyses of the individual S- and X-band traveling-wave maser (TWM) assemblies and their operational

configurations in the 70-meter antennas of NASA's Deep Space Network (DSN) are described. For the period 1990 through 1991, the TWM availability parameters for the Telemetry Data System are: mean time between failures (MTBF), 930 hr; mean time to restore services (MTTRS), 1.4 hr; and the average availability, 99.85 percent. In previously published articles, the performance analysis of the TWM assemblies was confined to the determination of the parameters specified above. However, as the mean down time (MDT) for the repair of TWM's increases, the levels of the TWM operational availabilities and MTTRS are adversely affected. A more comprehensive TWM availability analysis is presented to permit evaluation of both MTBF and MDT effects. Performance analysis of the TWM assemblies, based on their station monthly failure reports, indicates that the TWM's required MTBF and MDT levels of 3000 hr and 36 to 48 hr, respectively, have been achieved by the TWM's only at the Canberra Deep Space Station (DSS 43). The Markov Process technique is employed to develop suitable availability measures for the S- and X-band TWM configurations when each is operated in a two-assembly standby mode. The derived stochastic expressions allow for the evaluation of those configurations' simultaneous availability for the Antenna Microwave Subsystem. The application of these expressions to demonstrate the impact of various levels of TWM maintainability (or MDT) on their configurations' operational availabilities is presented for each of the 70-m antenna stations. Author

**N93-19436*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Radio Frequency and Microwave Sybsystems Section.

**A MODEL FOR THE COST OF DOING A COST ESTIMATE** **c83**

D. S. Remer (Harvey Mudd Coll., Claremont, CA.) and H. R. Buchanan *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 278-284 (For primary document see N93-19413 06-32)

(RTOP 314-40-31-30-03)

Avail: CASI HC A02/MF A03

A model for estimating the cost required to do a cost estimate for Deep Space Network (DSN) projects that range from $0.1 to $100 million is presented. The cost of the cost estimate in thousands of dollars, C(sub E), is found to be approximately given by C(sub E) = K((C(sub p))(sup 0.35)) where C(sub p) is the cost of the project being estimated in millions of dollars and K is a constant depending on the accuracy of the estimate. For an order-of-magnitude estimate, K = 24; for a budget estimate, K = 60; and for a definitive estimate, K = 115. That is, for a specific project, the cost of doing a budget estimate is about 2.5 times as much as that for an order-of-magnitude estimate, and a definitive estimate costs about twice as much as a budget estimate. Use of this model should help provide the level of resources required for doing cost estimates and, as a result, provide insights towards more accurate estimates with less potential for cost overruns. Author

**N93-19483*#** North Carolina State Univ., Raleigh. Dept. of Electrical and Computer Engineering.

**MOMENT METHOD ANALYSIS OF LINEARLY TAPERED SLOT ANTENNAS: LOW LOSS COMPONENTS FOR SWITCHED BEAM RADIOMETERS Final Report, 15 Jan. 1989 - 30 Sep. 1991**

Adnan Koeksal, Robert J. Trew, and J. Frank Kauffman Nov. 1992 229 p

(Grant NAG1-943)

(NASA-CR-192094; NAS 1.26:192094) Avail: CASI HC A11/MF A03

A Moment Method Model for the radiation pattern characterization of single Linearly Tapered Slot Antennas (LTSA) in air or on a dielectric substrate is developed. This characterization consists of: (1) finding the radiated far-fields of the antenna; (2) determining the E-Plane and H-Plane beamwidths and sidelobe levels; and (3) determining the D-Plane beamwidth and cross polarization levels, as antenna parameters length, height, taper angle, substrate thickness, and the relative substrate permittivity vary. The LTSA geometry does not lend itself to analytical solution with the given parameter ranges. Therefore, a computer modeling scheme and a code are necessary to analyze the problem. This necessity imposes some further objectives or requirements on the solution method (modeling) and tool (computer code). These may be listed as follows: (1) a good approximation to the real antenna geometry; and (2) feasible computer storage and time requirements. According to these requirements, the work is concentrated on the development of efficient modeling schemes for these type of problems and on reducing the central processing unit (CPU) time required from the computer code. A Method of Moments (MoM) code is developed for the analysis of LTSA's within the parameter ranges given. Author

**N93-19509#** Stanford Linear Accelerator Center, CA.

**COMPUTER CODES FOR RF CAVITY DESIGN**

K. Ko Aug. 1992 5 p Presented at the 16th International LINAC Conference, Ottawa, Ontario, 23-28 Aug. 1992

(Contract DE-AC03-76SF-00515)

(DE93-004002; SU-SLAC-PUB-5888; CONF-9208109-66) Avail: CASI HC A01/MF A01

In RF cavity design, numerical modeling is assuming an increasingly important role with the help of sophisticated computer codes and powerful yet affordable computers. A description of the cavity codes in use in the accelerator community has been given previously. The latest developments are addressed and their applications to cavity tuning and matching problems are discussed. DOE

**N93-19625#** Fermi National Accelerator Lab., Batavia, IL.

**REDUCING BUNCH DISRUPTION IN TRANSITION CROSSING BY MODIFICATION OF THE RF WAVEFORM**

J. MacLachlan, J. Griffin, C. Crawford, D. Wildman, C. Bhat, and M. Martens Jul. 1992 4 p Presented at the International Conference on High Energy Accelerators, Hamburg, Germany, 20-24 Jul. 1992

(Contract DE-AC02-76CH-03000)

(DE93-002509; FNAL/C-92/187; CONF-920706-45) Avail: CASI HC A01/MF A01

We investigate the utility of accelerating during the nonadiabatic period surrounding the time of transition with an RF waveform modified by a second or third harmonic component to eliminate RF focusing. Simulation study shows this scheme not only to control momentum spread but also to have apparent advantage with respect to microwave instability. An experimental test has been initiated in the Fermilab Main Ring using a cavity at the third harmonic of the RF. DOE

**N93-19787#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**ALGORITHIMS AND METHODS FOR PROCESSING SYNTHETIC APERTURE RADAR (SAR) IMAGES [ALGORITIMOS E METODOLOGIA DE PROCESSAMENTO PARA SINTESE DE IMAGENS DE RADAR DE ABERTURA SINTETICA (SAR)]**

Jose Claudio Mura Oct. 1991 12 p In PORTUGESE

(INPE-5301-PRE/1706) Avail: CASI HC A03/MF A01

The Synthetic Aperture Radar (SAR) concepts is presented in this work, and describes a digital processing method to SAR system. The Doppler model is used to derive algorithms to the SAR processing. Matched Filters are used to range and azimuth compression. This work also presents the number of arithmetic requirements to the SAR processing. Finally, some aspects of multi-look processing are presented. Transl. by FLS

**N93-19833#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**TEXTURE ENHANCEMENT OF SYNTHETIC APERTURE RADAR (SAR) IMAGES WITH SPECKLE NOISE REDUCTION FILTERS [REALCE DE TEXTURAS EM IMAGENS DE RADAR DE ABERTURA SINTETICA (SAR) POR FILTROS DE REDUCAO SPECKLE]**

Luciano Vieira Dutra and Nelson Delfino dAvil Mascarenhas Oct. 1991 11 p In PORTUGESE

(INPE-5297-PRE/1702) Avail: CASI HC A03/MF A01

Synthetic aperture radar images are becoming an increasingly important remote sensing data source because of their acquisition characteristics such as weather independence and soil humidity relationship. Unfortunately, they are disturbed by the so called 'speckle' noise which gives them a granular aspect masking the natural texture of terrain. Several filters have been proposed in the literature in order to reduce the speckle noise, but, in general, evaluation of the results have been subjective. A method is proposed to evaluate objectively filtering results, by determining the statistical models of texture classes and measuring a similarity distance between the classes. The experiments were made using a SAR580 image with three classes and three filters used for speckle suppression. The results showed a better performance with the sigma filter which agrees with the visual judgment. Author

**N93-19850#** Northwest Research Associates, Inc., Bellevue, WA.
**NEW METHODS FOR NONLINEAR TRACKING AND NONLINEAR CHAOTIC SIGNAL PROCESSING Final Report**
Jon A. Wright 18 Dec. 1992 36 p
(Contract N00014-92-C-0043)
(AD-A259331; NWRA-CR-92-R090) Avail: CASI HC A03/MF A01

The classic problem in signal processing is to identify a low strength signal in a noisy background. Even more difficult problems are to identify several signals in the noisy background, to determine the direction of the sources, and to track one or more of these multiple sources. In the next section we will give an overview of the techniques that we have developed for nonlinear signal identification. In the third section we will provide the details. In the fourth section we will give an overview of our nonlinear tracking methods, and in the fifth section we will give the details of the design of an array suitable for use with broadband signals. In the sixth section we will present the details of our nonlinear tracking algorithm for following a maneuvering vehicle. Classical, linear theory was used extensively in solving these problems. However, if the signals have a broad frequency spectrum with no readily identifiable characteristics, standard spectral methods are inadequate. In Phase 1, we have built upon some results of nonlinear dynamics to develop nonlinear algorithms to solve these problems, namely: (1) classify sources of multiple signals in a noisy environment; (2) determine the source direction if the receiver is an array; and (3) perform tracking of a maneuvering vehicle. GRA

**N93-19869#** Naval Research Lab., Washington, DC.
**SURVEY OF ANTENNA DESIGN COMPUTER MODELS Summary Report, Mar. - Sep. 1992**
Wendy L. Lippincott and Porter A. Lyon 24 Dec. 1992 74 p
(AD-A258765; NRL/MR/8113-92-7160; NRL/MR/6176-92-7160) Avail: CASI HC A04/MF A01

An overview of existing computer models available for antenna design and performance evaluation is presented. The various solution techniques, such as the method of moments, finite element and high frequency (asymptotic) techniques, are discussed along with their limitations with respect to frequencies, computer resources available, and antenna type and surrounding structures needed to be modeled. Sample problems are presented along with availability of the codes. Current areas of research are also discussed. GRA

**N93-19934*#** Arizona State Univ., Tempe. Dept. of Electrical Engineering.
**ANTENNA PATTERN CONTROL USING IMPEDENCE SURFACES Semiannual Progress Report, 16 Sep. 1990 - 15 Mar. 1991**
Constantine A. Balanis and Kefeng Liu 21 Mar. 1991 25 p
(Grant NAG1-1183)
(NASA-CR-192182; NAS 1.26:192182) Avail: CASI HC A03/MF A01

During this research period, September 16, 1990 to March 15, 1991, a design method for selecting a low-loss impedance material coating for a horn antenna pattern control has been developed. This method and the stepped waveguide technique can be employed to accurately compute the electromagnetic wave phenomenon inside the transition region of the horn antenna, with or without the impedance surfaces, from the feed to the radiating aperture. For moment method solutions of the electric and magnetic current distributions on the radiating aperture and the outer surface of the horn antenna, triangular surface-patch modes are introduced to replace the sinusoidal surface-patch modes as expansion and testing functions to provide a more physical expansion of the current distributions. In the synthesis problem, a numerical optimization process is formulated to minimize the error function between the desired waveguide modes and the modes provided by the horn transition with impedance surfaces. Since the modes generated by the horn transition with impedance surface are computed by analytical techniques, the computational error involved in the synthesis of the antenna pattern is minimum. Therefore, the instability problem can be avoided. A preliminary implementation of the techniques has demonstrated that the developed theory of the horn antenna pattern control using the impedance surfaces is realizable. Author

**N93-19949#** Aerospace Corp., El Segundo, CA.
**ACCURATE MEASUREMENT OF SIGNALS CLOSE TO THE NOISE FLOOR ON A SPECTRUM ANALYZER**
A. A. Moulthrop and M. S. Muha 30 Sep. 1992 20 p
(Contract F04701-88-C-0089)
(AD-A258666; TR-0091(6925-02)-2; SMC-TR-92-32) Avail: CASI HC A03/MF A01

Because most spectrum analyzers are calibrated to read the true power of a sinusoidal signal, a correction factor is necessary to read the true power of a nonsinusoidal signal, such as noise. Consequently, when noise and a sine wave are both present, a correction factor that is a function of the signal-to-noise ratio is necessary to find the true signal power. For some spectrum analyzers the correction factor for pure noise is incorporated into the software, but the correction for signal plus noise is generally ignored. This report derives this correction factor, which is significant when the signal-to-noise ratio is near unity. GRA

**N93-18744#** Geophysical Observatory, Sodankyla (Finland).
**EISCAT SVALBARD RADAR**
Markku Lehtinen and Jorma Kangas (Oulu Univ., Finland ) *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 49-64 (For primary document see N93-18736 06-46)
Avail: CASI HC A03/MF A02

**N93-18747#** Geophysical Observatory, Sodankyla (Finland).
**ON OPTIMIZATION OF RADAR MEASUREMENTS**
Markku Lehtinen *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 79-92 (For primary document see N93-18736 06-46)
Avail: CASI HC A03/MF A02

**N93-18748#** Geophysical Observatory, Sodankyla (Finland).
**APPLICATIONS OF THEORY OF EXPERIMENTS TO IS MEASUREMENTS**
Markku Lehtinen *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 93-102 (For primary document see N93-18736 06-46)
Avail: CASI HC A02/MF A02

**N93-18829*#** Rome Lab., Griffiss AFB, NY.
**THE DEVELOPMENT AND TESTING OF THE LENS ANTENNA DEPLOYMENT DEMONSTRATION (LADD) TEST ARTICLE**
Mark L. Pugh, Robert J. Denton, Jr., and Timothy J. Strange (Phillips Lab., Edwards AFB, CA.) *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 153-160 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

**N93-19397*#** Michigan Univ., Ann Arbor. Dept. of Electrical Engineering.
**NETWORK PROBLEM THRESHOLD**
Raghvendra Gejji, R. *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 171-198 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

**N93-19538#** Massachusetts Inst. of Tech., Westford. Haystack Observatory.
**NEXT GENERATION INCOHERENT SCATTER RADARS Abstract Only**
J. M. Holt *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19540#** Tromsoe Univ. (Norway).
**THEORY OF RADAR SCATTERING FROM DUSTY PLASMAS Abstract Only**
Cesar LaHoz *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19541#** Geophysical Observatory, Sodankyla (Finland).
**FAST FOURIER TRANSFORM: A SOLUTION FOR DIGITAL SIGNAL PROCESSING IN INCOHERENT SCATTER EXPERIMENTS? Abstract Only**

Tauno Turunen *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19543#** Cornell Univ., Ithaca, NY. National Astronomy and Ionosphere Center.
**TWO-DIMENSIONAL CHIRP MAPPING OF DEEP, FLUCTUATING RADAR TARGETS Abstract Only**
Tor Hagfors (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany) and E. D. Tereshchenko (Academy of Sciences, USSR, Murmansk) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19572#** Finnish Meteorological Inst., Helsinki.
**STARE: A NEW COHERENT RADAR IN SCANDINAVIA Abstract Only**
P. Janhunen, R. Pellinen, W. Schmidt, and J. Silen *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19573#** Rutherford High Energy Lab., Chilton (England).
**THE COSCAT EXPERIMENT: EISCAT OBSERVATIONS OF COHERENT SCATTER AT SMALL ASPECT ANGLES Abstract Only**
I. W. McCrea, K. Schlegel (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ), Tuomo Nygren (Oulu Univ., Finland ), T. R. Robinson (Leicester Univ., England), M. Lester (Leicester Univ., England), and T. B. Jones (Leicester Univ., England) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19574#** Auroral Observatory, Tromso (Norway).
**THE EISCAT SVALBARD (ARCTIC) RADAR Abstract Only**
N. Bjoernaa, B. Hultqvist (Swedish Inst. of Space Physics, Kiruna.), W. Kofman (Grenoble-1 Univ., France ), J. Roettger (EISCAT Scientific Association, Kiruna, Sweden ), K. Schlegel (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ), E. Turunen (Geophysical Observatory, Sodankyla, Finland ), and D. M. Willis (Rutherford Appleton Lab., Chilton, England ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19576#** Helsinki Univ. of Technology, Espoo (Finland). Dept. of Theoretical Physics.
**A GENERAL EXPERIMENT DEFINITION SYSTEM AND ITS APPLICATIONS Abstract Only**
Markku S. Lehtinen *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19577#** EISCAT Scientific Association, Kiruna (Sweden).
**THE G2-SYSTEM, A SECOND GENERATION EXPERIMENTAL PHILOSOPHY FOR EISCAT Abstract Only**
Gudmund Wannberg *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19578#** Southampton Univ. (England). Dept. of Physics.
**REAL AND SPURIOUS ANTICORRELATIONS BETWEEN V(PARALLEL) AND V(PERPENDICULARS) IN EISCAT DATA Abstract Only**
A. R. Breen and P. J. S. Williams (University Coll. of Wales, Aberystwyth.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19579#** EISCAT Scientific Association, Kiruna (Sweden).
**THE EISCAT UHF RADAR AS A METEOR RADAR: METEOR RADIAL VELOCITIES DETERMINED FROM A BARKER CODED POWER PROFILE Abstract Only**
Gudmund Wannberg and Asta Pellinen-Wannberg (Swedish Inst. of Space Physics, Kiruna.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19580#** EISCAT Scientific Association, Ramfjordbotn (Norway).
**ENHANCED ION-ACOUSTIC LINES IN EISCAT'S COMMON PROGRAMMES Abstract Only**
M. T. Rietveld, P. N. Collis (EISCAT Scientific Association, Kiruna, Sweden), A. P. vanEyken, K. Groves (Massachusetts Inst. of Tech., Westford.), and K. Tuovinen (EISCAT Scientific Association, Kiruna, Sweden ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19581#** EISCAT Scientific Association, Kiruna (Sweden).
**EISCAT RADAR OBSERVATIONS OF ENHANCED INCOHERENT SCATTER SPECTRA: THEIR RELATION TO RED AURORA AND FIELD-ALIGNED CURRENTS Abstract Only**
P. N. Collis, I. Haeggstroem (Swedish Inst. of Space Physics, Kiruna.), Kari U. Kaila (Oulu Univ., Finland ), and M. T. Rietveld (EISCAT Scientific Association, Ramfjordbotn, Norway ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19587#** Academy of Sciences (USSR), Murmansk. Polar Geophysical Inst.
**THE BICORE PROJECT Abstract Only**
Yu. Shchers, I. Sakharov, and M. Uspensky *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19771#** Istanbul Univ. (Turkey).
**ADVANCES IN SPEECH PROCESSING**
A. Nejat Ince *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 14 p (For primary document see N93-19757 06-54)
Copyright Avail: CASI HC A03/MF A03

**N93-19925#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction des Etudes de Synthese.
**RAMSES: MULTI-SPECTRAL EXPERIMENTAL RADAR STATION INSTALLED ON BOARD THE TRANSALL [RAMSES: STATION RADAR EXPERIMENTALE MULTI-SPECTRALE EMBARQUEE SUR TRANSALL]**
J. M. Boutry and D. LeCoz *In* AGARD, Flight Testing Oct. 1992 8 p In FRENCH (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A02/MF A04

## 33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

**N93-17959** ESDU International Ltd., London (England).
**ANALOGUE TO DIGITAL TRANSFORMATION**
Dec. 1992 47 p
(ESDU-92044; ISBN-0-85679-854-1) Avail: ESDU

ESDU 92044 examines the replacement of an analog controller element by an equivalent digital controller element while retaining for the new hybrid system performance characteristics that are acceptably similar to

those of the original continuous system. The main features are described of a system containing both analog and digital elements within the same loop, and the analog-to-digital and digital-to-analog components that are then necessarily a part of the system. The frequency response characteristics of transformation are discussed, introducing the problem of aliasing whereby a digital output can be matched by continuous sine waves of different frequencies that are then indistinguishable to the digital sampler. The need to avoid aliasing is considered and the concept of a folding frequency introduced below which aliasing is impossible. Two transformation methods for designing digital filters equivalent to analog filters are discussed: the impulse invariance and bilinear transformations. They are compared by examining digital equivalents of such analogue filters as simple and compound first-order lag and lead filters, second-order lag filters and first-order notch filters. The methods are compared for two sampling rates using Bode plots illustrating the gain and phase variation with frequency. An example based on an electromechanical instrument servo illustrates the transformation of an analog lag-lead controller using the bilinear transformation. ESDU

**N93-17989#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**DETERMINING THE EFFECTS OF MICROWAVE POWER VARIATIONS ON THE OUTPUT FREQUENCY OF A HIGH-PERFORMANCE CESIUM FREQUENCY STANDARD**

S. K. Karuza, W. A. Johnson, F. J. Voit, A. Leong, and J. P. Hurrell 30 Sep. 1992 18 p

(Contract F04701-88-C-0089)

(AD-A258342; TR-0091(6925-08)-2) Avail: CASI HC A03/MF A01

Previous investigations of cesium (Cs) frequency standards demonstrated that Rabi pulling and cavity pulling were the most significant effects that translated microwave power variations into output frequency variations. It was also shown that there exist optimum values of the C-field that make the output frequency insensitive to variations in microwave power. Using a completely automated measurement system, we performed a similar study on a dual-beam, high-performance Cs frequency standard. The microwave power was precisely calibrated, and the effects of microwave cavity tuning on the output frequency were measured. GRA

**N93-18057*#** Millitech Corp., South Deerfield, MA.

**SUBMILLIMETER SOURCES FOR RADIOMETRY USING HIGH POWER INDIUM PHOSPHIDE GUNN DIODE OSCILLATORS Final Report**

Naresh C. Deo 9 Feb. 1990 110 p

(Contract NAS7-996; SBIR-08.02-8551A)

(NASA-CR-190885; NAS 1.26:190885) Avail: CASI HC A06/MF A02

A study aimed at developing high frequency millimeter wave and submillimeter wave local oscillator sources in the 60-600 GHz range was conducted. Sources involved both fundamental and harmonic-extraction type Indium Phosphide Gunn diode oscillators as well as varactor multipliers. In particular, a high power balanced-doubler using varactor diodes was developed for 166 GHz. It is capable of handling 100 mW input power, and typically produced 25 mW output power. A high frequency tripler operating at 500 GHz output frequency was also developed and cascaded with the balanced-doubler. A dual-diode InP Gunn diode combiner was used to pump this cascaded multiplier to produce on the order of 0.5 mW at 500 GHz. In addition, considerable development and characterization work on InP Gunn diode oscillators was carried out. Design data and operating characteristics were documented for a very wide range of oscillators. The reliability of InP devices was examined, and packaging techniques to enhance the performance were analyzed. A theoretical study of a new class of high power multipliers was conducted for future applications. The sources developed here find many commercial applications for radio astronomy and remote sensing. Author

**N93-18098#** Technische Univ., Berlin (Germany). Fachbereich Mathematik.

**ON THE TIME DEPENDENT HYDRODYNAMIC MODEL FOR SEMICONDUCTORS Ph.D. Thesis**

Frank Jochmann 1992 78 p

(ETN-93-93027) Avail: CASI HC A05/MF A01

Existence theorem for weak and strong solutions of the time dependent hydrodynamic model for semiconductors is presented. The case of one carrier type is considered and the motion of charged particles in a semiconductor device under the influence of an electric field is described. A system of conservation laws is obtained and the assumption that the pressure depends only on the density is made. A local existence theorem for strong solution of the one dimensional hydrodynamic model for semiconductors is proven, by the theory of quasilinear equations of evolution in Banach spaces. Replacing the potential equation by Maxwell's equations for the electric and magnetic field, the local existence of strong solutions of the three dimensional hydrodynamic model is proven. To demonstrate the existence of global, discontinuous solutions, the notion of weak solution of the one dimensional model is introduced. ESA

**N93-18120#** California Univ., San Diego. Dept. of Electrical and Computer Engineering.

**DEVELOPMENT OF NEURAL MODULES BASED ON Si/PLZT TECHNOLOGY FOR OPTO-ELECTRONIC IMPLEMENTATIONS OF NEURAL NETWORKS Final Report, 1 Sep. 1989 - 31 May 1992**

Sadik C. Esener and Sing H. Lee 31 May 1992 38 p

(Grant AF-AFOSR-0018-90)

(AD-A257937; AFOSR-92-0923TR) Avail: CASI HC A03/MF A01

The objective of the research program was to design opto-electronic neuron modules communicating via free-space optical interconnects, and to develop Si/PLZT opto-electronic integrated circuit technology in order to implement these designs. First, device and system requirements for artificial neural networks were studied. Minimum performance requirements for artificial neural networks implementations were extracted. Next, two opto-electronic neural network architectures were developed. The first achieves reconfigurable optical interconnects using photorefractive crystals. This system was theoretically and experimentally investigated. The second architecture uses fixed, free-space, diffractive optical interconnects and electronically reconfigurable weights based on Si/PLZT technology. A prototype of this system was successfully built and tested. The performance of both systems exceed the minimum requirements. The first year effort involved the design of the optoelectronic architectures, the further development of the Si/PLZT process, the development of optimal neural network data encoding methods, and analysis of the system performance. the remaining period entailed the experimental demonstration of the correlation Matrix-Tensor Multipliers (CMTM) system, and the development, characterization, and application of the D-STOP prototype system. GRA

**N93-18173#** Massachusetts Inst. of Tech., Cambridge. Lab. for Electromagnetic and Electronic Systems.

**THEORETICAL ANALYSIS OF MICROWAVE AND MILLIMETER WAVE INTEGRATED CIRCUITS BASED ON MAGNETIC FILMS Annual Report, 1 Oct. 1991 - 30 Sep. 1992**

J. A. Kong 13 Nov. 1992 62 p

(Contract N00014-89-J-1019)

(AD-A257512) Avail: CASI HC A04/MF A01

A macroscopic model is proposed to explain nonlinear electromagnetic phenomena in superconductors. Nonlinear constitutive relations for electromagnetic problems are derived by modifying the linear London's equations. The superelectron number density n(s) is a function of the applied current density. The critical current density J(c) is derived classically from a critical energy E(c). For temperature T not equal to 0, the concept of critical current J(c) does not imply an abrupt transition of the whole sample from a superconducting state to a normal state when J is greater than J(c). A rather smooth variation of n(s)(J) is shown instead. The relation, n(s)(J), is derived from the Maxwellian distribution of electron velocities at a certain temperature T and a certain macroscopic current density J. Agreement has also been found between this n(s)(J,T) model and the temperature dependence of ns in the two-fluid model. The nonlinear conductivities sigma s(J) and sigma n(J) are obtained from the London's equation and the n(s)(J) function. Nonlinear resistance R(I), kinetic inductance L(k)(I) and surface impedance Z(s)(I) in thin wire, slab, and strip geometries of superconductors are calculated. A general scheme of solving nonlinear electromagnetic problems in superconductors is proposed. A good agreement between the theory and experiments has been found. GRA

**N93-18203#** SRI International Corp., Menlo Park, CA.

**FIELD-EMITTER ARRAYS FOR RF VACUUM MICROELECTRONICS Quarterly Report No. 4, 1 Jul. - 30 Sep. 1992**

C. A. Spindt, A. Rosengreen, and P. R. Schwoebel Nov. 1992 44 p

(Contract MDA972-91-C-0029; ARPA Order 8162)
(AD-A258211) Avail: CASI HC A03/MF A01

SRI International has completed the fourth quarter of a program to develop field-emitter arrays for vacuum microelectronics. The goals of the effort are 5 mA at 5 A/cm2 for at least 2 hours, and demonstrated modulation of the emission at 1 GHz. In-house technology was defined for the fabrication of low-frequency cathode structures on glass substrates. Fabrication and assembly of the apparatus required for microwave testing of the high-frequency cathode geometry was completed. Very-low-voltage cathode operation was demonstrated by fabricating cathode arrays using an experimental technique to produce gate apertures with 0.5-micrometer diameters. Current/voltage tests of high-frequency cathodes qualified them for testing in a microwave testing apparatus. A field-emission microscope was fabricated and assembled for use in basic surface studies with the potential of developing cathode processing techniques that will maximize emission stability and uniformity over an array. In bright light source research, 76,000 footlamberts was demonstrated with a standard P-53 phosphor and standard Spindt-type emitter array. GRA

**N93-18236#** Illinois Univ., Urbana. Coordinated Science Lab.
**STRUCTURE-BASED DESIGN AND ANALYSIS FOR CONCURRENT ERROR DETECTION AND RECOVERY IN RELIABLE ELECTRONIC SYSTEMS Final Report**
W. K. Fuchs Jul. 1992 4 p
(Contract N00014-89-K-0070)
(AD-A257790) Avail: CASI HC A01/MF A01

The complex digital electronic systems necessary for successfully attaining the SDIO mission will be composed of extremely large numbers of fine geometry active devices densely integrated with a potentially submicron interconnect. A major problem with the integration of these complex microelectronic circuits on VLSI chips and wafer-scale integration is that they become highly susceptible to physical failures and environmental disturbances, especially intermittent and transient failures. This problem is aggravated when these electronic systems are deployed in harsh environments potentially resulting in erroneous computation due to transient failures as projected in the SDIO mission. Failures can result in disastrous incorrect computational results or complete system shutdown. The purpose of this research has been to develop techniques for the design of highly reliable electronic digital systems based on the concurrent detection of errors and rapid recovery from failures and environmentally induced upsets. Concurrent error detection consistently monitors the correctness of computational results and allows for the detection of errors due to transient environmental upsets as well as permanent failures. Basic scientific results were obtained in this research concerning the derivation of design and analysis principles for concurrent error detection and recovery in electronic systems. GRA

**N93-18258#** Surveillance Research Lab., Salisbury (Australia).
**HF MOSFET POWER AMPLIFIERS**
K. Gooley, R. Debnam, and P. Hattam Feb. 1992 38 p
(AD-A258384; SRL-0081-TM) Avail: CASI HC A03/MF A01

Solid state devices are being increasingly used in RF power amplifiers. The work outlined in this paper was performed in order to keep HFRD abreast with the current state of technology, and to develop a potentially useful unit. This report covers the design of RF amplifiers in a general way, presents the performance test results of two HFRD manufactured amplifier modules (200 W and 500 W) and compares these with several commercially available units. GRA

**N93-18261#** SRI International Corp., Menlo Park, CA.
**ADVANCED ELECTRONIC STRUCTURES Technical Report No. 1, Mar. 1991 - Feb. 1992**
Mark VanSchilfgaarde Oct. 1992 17 p
(Contract N00014-91-C-0139)
(AD-A258401) Avail: CASI HC A03/MF A01

Contents: Schottky Barriers and Defects; Fullerene T(8)C(12); InTlSb as an Infrared Detector; Magnetic Multilayers; and Defects in HgCdTe. GRA

**N93-18278*** National Aeronautics and Space Administration. Pasadena Office, CA.
**CASCADED TRANSFORMERLESS DC-DC VOLTAGE AMPLIFIER WITH OPTICALLY ISOLATED SWITCHING DEVICES Patent**
Govind Sridharan, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 12 Jan. 1993 6 p Filed 22 Oct. 1991 Supersedes N92-17907 (30 - 8, p 1293)
(Contract NAS7-918)
(NASA-Case-NPO-17994-1-CU; US-Patent-5,179,289; US-Patent-Appl-SN-791759; US-Patent-Class-307-110; US-Patent-Class-363-60; Int-Patent-Class-H02M-3/07) Avail: US Patent and Trademark Office

A very high voltage amplifier is provided in which plural cascaded banks of capacitors are switched by optically isolated control switches so as to be charged in parallel from the preceding stage or capacitor bank and to discharge in series to the succeeding stage or capacitor bank in alternating control cycles. The optically isolated control switches are controlled by a logic controller whose power supply is virtually immune to interference from the very high voltage output of the amplifier by the optical isolation provided by the switches, so that a very high voltage amplification ratio may be attained using many capacitor banks in cascade. Official Gazette of the U.S. Patent and Trademark Office

**N93-18285*** National Aeronautics and Space Administration. Pasadena Office, CA.
**METHOD FOR NON-DESTRUCTIVE ESTIMATION OF WAVEGUIDE DIRECTIONAL COUPLER DIMENSIONS Patent**
Raul M. Perez, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 9 Feb. 1993 6 p Filed 22 Oct. 1991 Supersedes N92-17865 (30 - 8, p 1293)
(NASA-Case-NPO-18454-1-CU; US-Patent-5,185,046; US-Patent-Appl-SN-781521; US-Patent-Class-156-64; US-Patent-Class-156-279; Int-Patent-Class-B32B-31/00) Avail: US Patent and Trademark Office

A method for estimating the size and location of couplings within a waveguide directional coupler is provided. The method is applied to a waveguide directional coupler having a main transmission waveguide connected to an auxiliary transmission waveguide by a number of bore hold couplings. The bore hold couplings are in the interior of the waveguide directional coupler and, therefore, are not easily measurable. The method generally includes the steps of applying a two-sided tape to a member, inserting and securing the member within the main transmission waveguide, pouring a fine particulate substance such as talc into the auxiliary transmission waveguide such that a portion of the talc enters the bore hole couplings and adheres to the two-sided tape, and withdrawing the member such that the size and location of the bore hole couplings can be determined by measuring the size and location of marks on the two-sided tape caused by the fine particular substance adhering to the two-sided tape. Official Gazette of the U.S. Patent and Trademark Office

**N93-18316#** Department of the Navy, Washington, DC.
**METHOD AND APPARATUS FOR NON-DESTRUCTIVELY MEASURING LOCAL RESISTIVITY OF SEMICONDUCTORS Patent Application**
Kurt Gaskill, inventor (to Navy), N. Bottka, inventor (to Navy), and Alok K. Berry, inventor (to Navy) 17 Jun. 1992 28 p
(AD-D015534; US-Patent-Appl-SN-899977) Avail: CASI HC A03/MF A01

An apparatus for non-destructively measuring resistivity of a semiconductor, such as InP, comprises light sources for illuminating a preselected portion of the semiconductor with first and second light beams, each of a preselected single wavelength, the first light beam operating to excite the semiconductor by photo injecting carriers, and the second light beam bombarding the local portion of the semiconductor with a preselected photon energy. The apparatus measures a fractional change in reflectance of the second light beam responsive to the first light beam, and records this fractional change in reflectance for various values of photon energy of the second light beam, to generate a photoreflectance line-shape. The photoreflectance line-shape is used to calculate a photoreflectance line-shape phase angle, which is used to determine the resistivity of the preselected portion of the semiconductor. Author (GRA)

**N93-18317#** Department of the Navy, Washington, DC.
**WIRE ASSEMBLY FOR ELECTRICALLY CONDUCTIVE CIRCUITS Patent Application**
Walter T. Schneider, inventor (to Navy) Apr. 1992 9 p

(AD-D015535; US-Patent-Appl-SN-866921) Avail: CASI HC A02/MF A01

A wire assembly for electrically conductive circuits is described. The assembly is comprised of a circuit conductor wire having a coating of insulative material thereon, a shielding foil wrapped at least partially around the coating and having a leg portion extending outwardly from the coating, a shield conductor wire fixed to the shielding foil, and an insulative outer layer enclosing the shielding foil and the shield conductor wire. GRA

**N93-18328#** Naval Postgraduate School, Monterey, CA.
**CURRENT DENSITY LIMITATIONS IN A FAST-PULSED HIGH-VOLTAGE DIODE M.S. Thesis**
David S. Welsh Jun. 1992 63 p
(AD-A257866) Avail: CASI HC A04/MF A01

An investigation into the limitations on the enhanced field-emitted current density in a fast-pulsed (rise-time on the order of ns), high voltage (greater than 10(exp 6) V), 1-inch vacuum diode was conducted using a computer simulation based on the Fowler-Nordheim equation. Oscillations in the emitted current density (due to the change in the amount of space charge within the gap) were found to quickly decay into a final steady-state for the voltages applied. Steady-state values for a wide variety of work functions, electric field enhancement factors (based on the theory that whiskers on the cathode surface experience varying degrees of enhancement), and applied potentials were compare to two benchmarks: the amount of current density required to explode a whisker in less than 10 ns by joule heating (J(sub E) = 10(exp 9) A/sq cm); and the Child-Langmuir (C-L) space-charge-limited current density. GRA

**N93-18341#** IBM Research Lab., Yorktown Heights, NY.
**THREE-TERMINAL SUPERCONDUCTING DEVICE RESEARCH Final Report, 16 Sep. 1985 - 15 Jan. 1991**
William J. Gallagher 18 Sep. 1992 96 p
(Contract N00014-85-C-0361)
(AD-A257907) Avail: CASI HC A05/MF A01

The goal of this cost-shared contract research was to investigate potential new three-terminal cryogenic device structures in order to explore new regimes of device physics and ultimately to develop better cryogenic superconducting devices. There were three principal thrusts during the term of this contract: Submicron injection-controlled weak links; ultrashort FET's with superconducting source and drain contacts which induce superconductivity in the channel; and electric field induced changes in the carrier densities of high-Tc materials. In each case our approach was to fabricate, study, and analyze experimental structures with the aim of understanding device potential. In addition to the above three terminal device thrusts, because of the enormous new opportunity that the discovery of high temperature superconductivity offered, a portion of the contract effort was directed at elucidating the basic properties of these materials with the aim of understanding their device potential. GRA

**N93-18365#** Purdue Univ., West Lafayette, IN.
**RECONFIGURATION SCHEMES FOR FAULT-TOLERANT PROCESSOR ARRAYS Final Report, 1 Jul. 1988 - 31 Aug. 1992**
Jose A. Fortes 15 Oct. 1992 216 p
(Contract N00014-88-K-0723)
(AD-A257833) Avail: CASI HC A10/MF A03

This project addressed several aspects of the problem of designing highly-reliable dynamically reconfigurable processor arrays. The proposed work focused mainly on reconfiguration schemes required to implement fault-tolerant processor arrays. According to the original statement of work, the following complementary objectives were pursued: (1) a methodology for the design and evaluation of processor-switched arrays; (2) a methodology for the design and evaluation of multi-level hierarchically reconfigurable processor arrays; (3) a methodology for the design of fault-tolerant interconnection routers for processor arrays with decentralized routing control; and (4) algorithm reconfiguration strategies which, together with hardware reconfiguration schemes, can be used to achieve graceful degradation in processor arrays. The emphasis of the proposed research was on the development of optimal reconfiguration schemes for each of the above objectives by using mathematical and simulation tools. For this purpose, evaluation methods and adequate measures were also studied and developed. These measures include not only reliability but also joint measures of performance, hardware area and reliability. GRA

**N93-18391#** California Univ., Berkeley. Lawrence Berkeley Lab.
**THE FABRICATION AND PERFORMANCE OF YBa2Cu3O(7-x) SQUID MAGNETOMETERS Ph.D. Thesis**
J. J. Kingston Jul. 1992 126 p
(Contract DE-AC03-76SF-00098)
(DE93-002561; LBL-32660) Avail: CASI HC A07/MF A02

To enhance the SQUID's field sensitivity, it is coupled to a flux transformer, a closed superconducting circuit consisting of a pickup loop, to which a signal is applied. It is then connected in series to an input coil, which is inductively coupled to the SQUID. To fabricate an optimal flux transformer, one must use more than one superconducting thin-film layer, each of which is patterned into narrow strips or wires. Some wires from different layers cross, yet remain electrically isolated, to form crossovers, while in other places there must be superconducting contact between wires from different layers. Together, the superconducting wire, superconducting-superconducting contact, and the superconducting crossover constitute a superconducting interconnect or multilayer wiring technology. We discuss the development of an interconnect technology involving the high transition temperature (Tc) superconductor YBa2Cu3O(7-x) (YBCO). Because of the need for epitaxial growth, there are limits on materials for the insulating layer separating the YBCO films in multilayer structures, and on deposition and patterning techniques. We discuss the use of pulsed laser deposition in conjunction with patterning by shadow masks and later by photolithography to produce interconnects, multiturn input coils, and flux transformers. We also discuss the performance of SQUID magnetometers, in which a flux transformer fabricated on one substrate is coupled to a SQUID fabricated on another. The first magnetometers were hybrids (high (Tc) transformers coupled to low (Tc) SQUIDS) while later ones had both high (Tc) transformers and SQUIDS and could operate immersed in liquid nitrogen. We report on a magnetometer with a magnetic field sensitivity at 1 Hz of about 2pTHz exp(-1/2) at 77K, that was successfully used to perform magnetocardiograms on human subjects. DOE

**N93-18420#** Aerospace Corp., El Segundo, CA.
**HPM DAMAGE THRESHOLDS OF GaAs FETs AND HEMTs**
A. A. Moulthrop, M. S. Muha, R. B. Dybal, and H. J. Winthoub 30 Sep. 1992 24 p
(Contract F04701-88-C-0089)
(AD-A257897; TR-0090(5925-02)-1; SMC-TR-92-33) Avail: CASI HC A03/MF A01

Measurements are presented of the damage thresholds of low-noise gallium arsenide (GaAs) field-effect transistors (FET's) and high-electron-mobility transistors (HEMT's) when these devices are exposed to high-power microwave pulses. Because the devices measured have gate lengths of one-half micron or less, they represent the state of the art and thus provide a susceptibility database for receiver- and system-design engineers. As the devices were biased for low-noise operation at room temperature, most of these measurements simulated normal system operation. However, to determine the effects of temperature on the damage threshold, several measurements were made at -20 and 95 C. Also, measurements were made under different conditions of bias on the device and different frequency content of the microwave input (i.e., single and multiple tones), to determine the effect of these factors. GRA

**N93-18764*#** Catholic Univ. of America, Washington, DC. Dept. of Electrical Engineering.
**CAPACIFLECTOR-BASED VIRTUAL FORCE CONTROL AND CENTERING Semiannual Progress Report**
Charles C. Nguyen 1 Feb. 1993 12 p
(Grant NAG5-780)
(NASA-CR-191805; NAS 1.26:191805) Avail: CASI HC A03/MF A01

This report presents a novel concept of force control, called virtual force control. The virtual force concept avoids sudden step transition of position control to contact force control resulting in contact force disturbance when a robot end-effector makes contact with the environment. A virtual force/position control scheme consists of two loops: the force control loop and the position control loop. While the position control loop regulates the free motion, the force control loop regulates the contact force after making contact with the environment and the virtual force measured by a range sensor called capaciflector in the virtual environment. After presenting the concept of virtual force control, the report introduces a centering scheme

in which the virtual force controller is employed to measure three points on a cone so that its center can be located. Experimental results of a one-degree-of-freedom virtual force control scheme applied in berthing an orbital replaceable unit are reported and compared with those of conventional pure contact force control cases. Author

**N93-18959#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A GENERIC TEMPLATE EXTRACTOR (GENTEX) IN C FOR VLSI DESIGN VERIFICATION M.S. Thesis**

Kenneth J. McClellan, Jr. Dec. 1992 123 p

(AD-A259078; AFIT/GE/ENG/92D-25) Avail: CASI HC A06/MF A02

The problem of VLSI design verification through circuit extraction was analyzed. The problems of creating a simple template format, the permutability of pins, maintaining connectivity, and performance were focused on. A generic template extractor (GENTEX) was developed in the C programming language for use as a testbed to find solutions to these problems. Six different extraction algorithms were tested with GENTEX and compared based on performance. EDIF translation programs were used to interface with GENTEX on both the input and output sides. One translation program converted an EDIF representation of a schematic into the template format used by GENTEX. The other translation program converted the output of GENTEX into a schematic in EDIF. The results of the performance analysis showed that an extraction algorithm based on searching the data structures by node rather than by component type provided the best performance. The results also showed that comparing the number of connections to a node within a template to the actual number of connections to a node within the circuit being extracted, not only eliminated any connectivity problems but also increased performance. GRA

**N93-19012#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**PARALLEL SIMULATION OF STRUCTURAL VHDL CIRCUITS ON INTEL HYPERCUBES M.S. Thesis**

Thomas A. Breeden Dec. 1992 169 p

(AD-A258999; AFIT/GCS/ENG/92D-01) Avail: CASI HC A08/MF A02

Many VLSI circuit designs are too large to be simulated with VHDL in a reasonable amount of time. One approach to reducing the simulation time is to distribute the simulation over several processors. This research creates an environment for designing and simulating structural VHDL circuits on the Intel iPSC/2 and iPSC/860 Hypercubes. Logic gates and system behaviors are partitioned among the processors, and signed changes are shared via event messages. Circuit simulations are run over the SPECTRUM parallel simulation testbed, and the null-message paradigm is used to avoid deadlock. Structural circuits ranging from forty to over one thousand logic gates are correctly simulated. Although no attempt is made to find optimal partitioning strategies, speedups are obtained for some configurations. GRA

**N93-19048#** Microelectronics Center of North Carolina, Research Triangle Park.

**FIELD EMITTER ARRAY RF AMPLIFIER DEVELOPMENT PROJECT. PHASE 1: CATHODE TECHNOLOGY DEVELOPMENT Special Technical Report**

Bertram Hui 17 Nov. 1992 11 p

(Contract MDA972-91-C-0028)

(AD-A258768) Avail: CASI HC A03/MF A01

The initial RF modulation testing of the gated column silicon field emitter with a diamond coating has been done. It should be noted that we didn't use 50 ohm coaxial cable inside the vacuum chamber for this testing since the configuration was initially used for DC testing, and we wanted to get earlier AC results at this time. It is well known that the mismatch of the circuit will give a lot of loss during the RF measuring. This report completes modulation at 0.36 GHz, and even higher performance is expected after full blown AC testing. The DC characteristic, as shown in Fig. 2, of this device is comparable to what we reported from the standard silicon field emitter (2 microns opening at gate and 1 micron height, tip is 1 micron below the bottom of gate electrode, and the tip radius is more than 600 A). The diamond-like film was coated on the silicon tips by remote plasma diamond-like film deposition techniques with a short sputtering etching before deposition and to a thickness of approximately 100 A. GRA

**N93-19051*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**PROCESS FOR APPLYING A SUPERCONDUCTIVE POWDER TO A WIDE VARIETY OF SUBSTRATES Patent Application**

Matthew W. Hooker, inventor (to NASA) (Clemson Univ., SC.), Stephanie A. Wise, inventor (to NASA), and Sang Q. Tran, inventor (to NASA) 17 Dec. 1992 9 p

(NASA-Case-LAR-14729-1-CU; NAS 1.71:LAR-14729-1-CU;

US-Patent-Appl-SN-999695) Avail: CASI HC A02/MF A01

A fine superconducting powder such as YBa2Cu3O(7-x), wherein x is less than one, is blended into a liquid mixture comprising an epoxy resin and a thinner. This liquid mixture with the blended superconducting powder is coated onto a substrate. Next, the thinner is evaporated and the remaining coating cured, resulting in a coating of cured epoxy resin having superconducting powder suspended therein. This coating exhibits the Meissner effect, i.e., it expels a magnetic flux which protects the substrate from external magnetic interference. Since the coated substrate need only be heated for evaporation and curing at relatively low temperatures compared to firing, the superconducting coating can be applied to a wide variety of different materials. NASA

**N93-19058** Cornell Univ., Ithaca, NY.

**AN EXPERIMENTAL INVESTIGATION OF A TANDEM RELATIVISTIC BACKWARD WAVE OSCILLATOR-TRAVELLING WAVE TUBE AMPLIFIER SYSTEM FOR GENERATING HIGH-POWER MICROWAVES Ph.D. Thesis**

Gilberto Barreto 1992 144 p

Avail: Univ. Microfilms Order No. DA9300843

The experimental investigation described in this dissertation demonstrates the feasibility of generating long (greater than or equal to 50 nsec) pulses of high-power (greater than or equal to 100 MW), X-band frequency microwaves. In these experiments, a relativistic Backward Wave Oscillator (BWO) is used in tandem with a Traveling Wave Tube (TWT) amplifier to generate microwave radiation. The tandem BWO TWT system is driven in the TM(sub 01) mode by a single annular, relativistic electron beam, which is guided through the two rippled-wall slow wave structures by an applied axial magnetic field. A special RF sever placed between the BWO and TWT slow wave structures prevents electromagnetic coupling between the oscillator and amplifier while allowing the electron beam to pass from one structure to the other. In this way, the BWO serves to modulate the beam that subsequently drives the TWT producing high-power, phase stable microwave radiation. To obtain microwave pulses with pulsewidths comparable to the electron beam duration, the BWO is operated below saturation levels in order to minimize the pulse-shortening effects that are characteristic of very high-power BWOs. A set of BWO characterization experiments are conducted to determine the optimum operating conditions for this oscillator/modulator. When driven with a beam of approx. 100 nsec duration, the tandem BWO-TWT device is found capable of producing 50-60 nsec wide microwave pulses with peak output powers in excess of 100 MW. Overall beam-to-microwave efficiencies as high as 35 percent are observed. The operating frequency of the tandem device is tuned between 11-12 GHz by varying the effective energy of the beam. The tandem BWO-TWT system described here can be scaled up in size to produce peak output power levels in the gigawatt range. This type of system is ideal for use in phased array antenna applications that require an easily controlled source of high power density microwave radiation. Dissert. Abstr.

**N93-19107*#** Illinois Univ., Urbana. Dept. of Computer Science.

**A COMPARISON OF MULTIPROCESSOR SCHEDULING METHODS FOR ITERATIVE DATA FLOW ARCHITECTURES**

Matthew Storch Feb. 1993 22 p

(Grant NAG1-613; RTOP 586-03-11)

(NASA-CR-189730; NAS 1.26:189730; UIUCDCS-R-92-1776;

UILU-ENG-92-1756) Avail: CASI HC A03/MF A01

A comparative study is made between the Algorithm to Architecture Mapping Model (ATAMM) and three other related multiprocessing models from the published literature. The primary focus of all four models is the non-preemptive scheduling of large-grain iterative data flow graphs as

required in real-time systems, control applications, signal processing, and pipelined computations. Important characteristics of the models such as injection control, dynamic assignment, multiple node instantiations, static optimum unfolding, range-chart guided scheduling, and mathematical optimization are identified. The models from the literature are compared with the ATAMM for performance, scheduling methods, memory requirements, and complexity of scheduling and design procedures.
Author

**N93-19330*#** National Aeronautics and Space Administration. Pasadena Office, CA.
**AMTEC VAPOR-VAPOR SERIES CONNECTED CELLS Patent Application**
Mark L. Underwood, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), Robert M. Williams, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), Margaret A. Ryan, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), Barbara Jeffries-Nakamura, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and Dennis OConnor, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 11 Jan. 1993 21 p
(Contract NAS7-918)
(NASA-Case-NPO-18667-1-CU; NAS 1.71:NPO-18667-1-CU; US-Patent-Appl-SN-004162) Avail: CASI HC A03/MF A01

An alkali metal thermoelectric converter (AMTEC) having a plurality of cells structurally connected in series to form a septum dividing a plenum into two chambers, and electrically connected in series, is provided with porous metal anodes and porous metal cathodes in the cells. The cells may be planar or annular, and in either case a metal alkali vapor at a high temperature is provided to the plenum through one chamber on one side of the wall and returned to a vapor boiler after condensation at a chamber on the other side of the wall in the plenum. If the cells are annular, a heating core may be placed along the axis of the stacked cells. This arrangement of series-connected cells allows efficient generation of power at high voltage and low current. NASA

**N93-19342#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DESIGN AND DEVELOPMENT OF A HIGH-SPEED WINOGRAD FAST FOURIER TRANSFORM PROCESSOR BOARD M.S. Thesis**
James F. Herron Dec. 1992 172 p
(AD-A258919; AFIT/GCE/ENG/92D-05) Avail: CASI HC A08/MF A02

Since 1985, the Air Force Institute of Technology has pursued a project to develop a 4080-point Discrete Fourier Transform processor using the Winograd Fourier Transform Algorithm (WFTA) and Good-Thomas Prime Factoring Algorithm (PFA). In the first attempt to build a working system, this research effort designed and constructed, in part, a modified single processor architecture in order to demonstrate the proof of concept of the WFTA system design. This prototype architecture is simpler in implementation but uses the same principles and procedures as those of the 4080-point WFTA design. The design developed in this thesis was validated using the Very High-Speed Integrated Circuit Hardware Description Language (VHDL) to simulate its operation. A partial construction of the design was built and tested verifying the VHDL results. GRA

**N93-19446#** Westinghouse Electric Corp., Baltimore, MD.
**DARPA INITIATIVE IN CONCURRENT ENGINEERING (DICE). PHASE 4: ELECTRONICS PILOT PROJECT Final Technical Report, 30 Sep. 1991 - 15 Oct. 1992**
Michael Lucas, Ubaid Qudsi, Patti Brence, William Garber, and Robert Michaels 30 Nov. 1992 118 p
(Contract MDA972-91-C-0039; ARPA Order 8290)
(AD-A258927) Avail: CASI HC A06/MF A02

This report describes the performance of a pilot project using DICE technology for the design of an electronics module. The project objectives were to assess the capability of the DICE technology to enable computer-based concurrent engineering and to provide recommendations for improvement. Four DICE software tools were used to design a high performance signal processor module. These tools consisted of the Electronic Design Notebook, the Project Coordination Board, Meeting on the Net, and the Communications Manager. The primary conclusion drawn from the project was that the DICE technology has a large potential to improve the product development process in terms of decreased product development cost, reduced cycle time, and improved product quality. The specific implementations of the four DICE tools evaluated in this pilot project, however, provided only a small portion of this potential. The numerous recommendations developed during the course of the project will, if incorporated into the DICE technology, help the technology reach its full potential. GRA

**N93-19482#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**[RESEARCH PROGRAMS AT THE RESEARCH LABORATORY OF ELECTRONICS] Progress Report No. 134, 1 Jan. - 31 Dec. 1991**
Jonathan Allen, Daniel Kleppner, and Barbara Passero, ed. 31 Dec. 1991 374 p Original contains color illustrations
Avail: CASI HC A16/MF A03

The progress report of the Research Laboratory of Electronics is presented. The following topics are addressed: (1) solid state physics, electronics, and optics including materials and fabrication, quantum effect devices, optics and devices, and surfaces and interfaces; (2) applied physics including atomic, molecular, and optical physics, plasma physics, electromagnetics, and radio astronomy; (3) systems and signals including computer aided design, and digital signal processing; and (4) language, speech, and hearing including speech communication, sensory communication, auditory physiology, and linguistics. L.R.R.

**N93-19637#** Sandia National Labs., Albuquerque, NM.
**DOE BATTERY PROGRAM FOR WEAPON APPLICATIONS**
R. P. Clark and A. R. Baldwin 1992 6 p Presented at the 8th Annual Battery Conference on Applications and Advances, Long Beach, CA, 12-14 Jan. 1993
(Contract DE-AC04-76DP-00789)
(DE93-002476; SAND-92-1835C; CONF-930152-1) Avail: CASI HC A02/MF A01

This report discusses the Department of Energy (DOE) Weapons Battery program which originates from Sandia National Laboratories (SNL) and involves activities ranging from research, design and development to testing, consulting, and production support. The primary customer is the DOE/Office of Defense Programs, although work is also done for various Department of Defense agencies and their contractors. The majority of the SNL activities involve thermal battery (TB) and lithium ambient temperature battery (LAMB)technologies. Smaller efforts are underway in the areas of silver oxide/zinc and nickel oxide/cadmium batteries as well as double layer capacitors. DOE

**N93-19740#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**EXPERIMENTAL STUDY OF THE SELECTIVE PROPERTIES OF COAXIAL RESONATORS [ESTUDO EXPERIMENTAL DAS PROPRIEDADES SELETIVAS DE RESSOADORES COAXIAIS]**
Pedro Jose deCastro, Joaquim Jose Barroso, and Rafael Alves Correa 1992 9 p In PORTUGESE
(INPE-5375-PRE/1748) Avail: CASI HC A02/MF A01

A study of the selective properties of open cylindrical coaxial cavities was conducted experimentally and compared with the wave theory where ohmic effects are included. The outside structure of the cavity comprises a weakly irregular wave guide, while the internal conductor consists of a homogeneous cylinder. Fundamental TE mode sequences are identified over the range of 9 to 17 GHz through measurement of the resonant frequencies and the quality factors associated with the various modes. It was verified that the number of normal modes in a given sequence depends upon the geometry of the central cylinder considered. Transl. by FLS

**N93-19853#** California Univ., Santa Barbara. Dept. of Electrical and Computer Engineering.
**DISTRIBUTED NONLINEAR DEVICES FOR MILLIMETER-WAVE AND PICOSECOND PULSE GENERATION Final Report, 15 May 1989 - 14 May 1992**
Mark Rodwell 1992 18 p
(Grant AF-AFOSR-0394-89)
(AD-A259372; AFOSR-93-0004TR) Avail: CASI HC A03/MF A01

The program goal was to demonstrate monolithic Schottky diode GaAs circuits for efficient generation of harmonics of microwave drive signals

and for efficient generation of picosecond impulses. The method is nonlinear wave propagation on monolithic GaAs nonlinear transmission lines (NLTL's). Through generation of shock wave NLTL's, we had previously demonstrated generation of picosecond step-functions. A modified version of the NLTL can be used for picosecond pulse generation and frequency multiplication. GRA

**N93-19860*#** Creare, Inc., Hanover, NH.
**THREE-PHASE INVERTER FOR SMALL HIGH SPEED MOTORS Final Report, May 1989 - May 1991**
John A. McCormick and Javier A. Valenzuela Jul. 1991 92 p
(Contract NAS5-30630; SBIR-09.05-3800)
(NASA-CR-191331; NAS 1.15:191331; TM-1499) Avail: CASI HC A05/MF A01

A high-frequency three-phase inverter is being developed to drive a miniature centrifugal compressor which is a key component in a long-life space-borne cryocooler. The inverter is a unique transformer-coupled design, tailored to the low-voltage high-current characteristic of the compressor's induction motor. The design and performance demonstration of a breadboard model of the inverter are described. The cryocooler uses a reverse-Brayton cycle with turbomachines to provide 5 watt of cooling at 70 K. The design target for input power to the compressor motor is 175 watts. Line-to-neutral phase voltage waveforms to be supplied by the inverter have an amplitude of 15 volt-rms at a frequency of 8 kHz. DC power at 28 volt is supplied to the inverter. The breadboard inverter was tested with a preliminary development model of the compressor. It drove the compressor over a range of operating conditions encompassing frequencies of 5 to 9 kHz at powers of 56 to 437 watt. Inverter efficiencies, calculated from experimentally verified loss models, ranged from 89 to 95 percent over the tests. The design target on efficiency is 90 percent. The inverter was demonstrated to supply starting current adequate to overcome the starting friction of the compressor's self-acting gas bearings by a safe margin. Author

**N93-19861#** Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Electrical and Computer Engineering.
**ADVANCED CONCEPTS IN DISTORTION-INVARIANT PHASE-ONLY FILTER DESIGN Final Report, May 1989 - Feb. 1992**
B. V. Kumar Jul. 1992 128 p
(Contract F19628-89-K-0032)
(AD-A258691; RL-TR-92-208) Avail: CASI HC A07/MF A02

The classical matched filter is analytically optimal for detecting a target in white additive noise, when SNR is defined in the classical way. However, the complex transmittance values pose problems in their practical realization. The phase-only filter solves this problem but generally adds some noise to the correlation signal. This report studies ways of optimizing the performance of the phase-only filter. This includes the presence of non-white or colored noise in the input scene and detector noise. Formulas are derived and the results tested using actual images of real military armaments. GRA

**N93-19893*#** Auburn Univ., AL. Center for the Commercial Development of Space Power.
**SILICON DEVICE PERFORMANCE MEASUREMENTS TO SUPPORT TEMPERATURE RANGE ENHANCEMENT Semiannual Report, 7 May - 9 Nov. 1992**
James Bromstead, Bennett Weir, Melvin Cosby, R. Wayne Johnson, R. Mark Nelms, and Ray Askew 7 Dec. 1992 10 p
(Contract NCC3-175)
(NASA-CR-191957; NAS 1.26:191957) Avail: CASI HC A02/MF A01

Characterization results of a MOS controlled thyristor (MCTA60P60) are presented. This device is rated for 60A and for an anode to cathode voltage of -600 V. As discussed in the last report, the MCT failed during 500 V leakage tests at 200 C. In contrast to the BJT (bipolar junction transistor), MOSFET, and IGBT (insulated gate bipolar transistor) devices tested, the breakdown voltage of the MCT decreases significantly with increasing temperature. Author

**N93-18460#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**ACOUSTO-OPTIC FREQUENCY EXCISION**
M. J. OLoughlin, D. G. Heflinger, W. E. Yamada, D. C. Mayer, and R. S. Boughton *In its* Aerospace Sponsored Research 1 Dec. 1991 p 5-7 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18461#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**DEVICE APPLICATIONS OF LAYERED STRUCTURES**
R. C. Lacoe, W. L. Bloss, M. J. OLoughlin, D. A. Gutierrez, and R. C. Cole *In its* Aerospace Sponsored Research 1 Dec. 1991 p 8-11 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18462#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**VLSI MICROELECTRONICS RESEARCH**
D. C. Mayer, D. L. Leung, and R. C. Cole *In its* Aerospace Sponsored Research 1 Dec. 1991 p 11-14 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18463#** Aerospace Corp., El Segundo, CA. Electronics and Sensors Div.
**NONLINEAR CIRCUITS AND COMPONENTS**
C. P. Silva *In its* Aerospace Sponsored Research 1 Dec. 1991 p 14-17 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18464#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**HIGH-TEMPERATURE SUPERCONDUCTING ELECTRONICS**
R. C. Lacoe, J. P. Wendt, D. A. Gutierrez, and J. P. Hurrell *In its* Aerospace Sponsored Research 1 Dec. 1991 p 18-21 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18465#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**NOVEL INTERCONNECT DEPOSITION TECHNOLOGY**
D. M. Speckman and J. P. Wendt *In its* Aerospace Sponsored Research 1 Dec. 1991 p 21-23 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18904*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DETERMINATION OF THE DISSIPATIVE LOSS OF A TWO-PORT NETWORK FROM NOISE TEMPERATURE MEASUREMENTS**
T. Y. Otoshi *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 71-74 (For primary document see N93-18897 06-32)
(RTOP 310-20-65-86-08)
Avail: CASI HC A01/MF A03

**N93-18908*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**APPLICATION OF MULTIRATE DIGITAL FILTER BANKS TO WIDEBAND ALL-DIGITAL PHASE-LOCKED LOOPS DESIGN**
R. Sadr, B. Shah, and S. Hinedi *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 101-117 (For primary document see N93-18897 06-32)
(RTOP 310-30-70-92-01)
Avail: CASI HC A03/MF A03

**N93-18919*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**MINIMIZING NOISE-TEMPERATURE MEASUREMENT ERRORS**
C. T. Stelzried *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 254-268 (For primary document see N93-18897 06-32)
(RTOP 314-40-31-30-06)
Avail: CASI HC A03/MF A03

**N93-18920*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**CORRECTION OF HIGH-FREQUENCY NOISE-TEMPERATURE INACCURACIES**
C. T. Stelzreid *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 269-277 (For primary document see N93-18897 06-32)

(RTOP 314-40-31-30-06)
Avail: CASI HC A02/MF A03

**N93-18926*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**AN ANALYSIS OF I/O EFFICIENT ORDER-STATISTIC-BASED TECHNIQUES FOR NOISE POWER ESTIMATION IN THE HRMS SKY SURVEY'S OPERATIONAL SYSTEM**
G. A. Zimmerman and E. T. Olsen *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 340-351 (For primary document see N93-18897 06-32)
(RTOP 108-30-30-40-04)
Avail: CASI HC A03/MF A03

## 34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

**N93-17815#** United Technologies Corp., San Jose, CA. Chemical Systems Div.
**OSCILLATORY INTERNAL FLOW FIELDS STUDIES Final Report**
C. W. Shaeffer and R. S. Brown 30 Aug. 1992 90 p Sponsored by AFOSR
(AD-A258005; AFOSR-92-0958TR) Avail: CASI HC A05/MF A01

Experimental studies have been conducted to measure the structure of oscillatory waves in the presence of the rotational flow field which characterizes the internal ballistics of solid propellant rockets. Cold flow results demonstrated that extensive rotational behavior of oscillatory flows are associated with the types of flows. These rotational effects extend over significant portions of the chamber volume, both radially and axially. Radial variations in the amplitude of the axial oscillatory velocity appear to be related to radial momentum effects. The distance between the peaks correlates with approximate solutions of the radial momentum equation. Further downstream, convection effects from the mean flow distorts these radial variations at low surface Mach numbers. Significant nonlinear behavior was observed near the wall at three axial stations. At lower surface mach numbers, this behavior extended all the way across the chamber at the downstream location (5.46 diameters). This nonlinear behavior occurred at a much lower oscillatory pressure than previously expected. From the observed effect of surface Mach number, it appears the nonlinearities are associated with interactions between the mean and oscillatory flows. GRA

**N93-17847#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**GALERKIN COARSE GRID APPROXIMATION FOR THE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS IN GENERAL COORDINATES**
S. Zeng and P. Wesseling 1992 21 p
(Rept-92-35; ETN-93-93127) Copyright Avail: CASI HC A03/MF A01

A part of multigrid methods, namely Galerkin coarse grid approximation, is discussed for the incompressible Navier-Stokes equations in general coordinates, for two dimensional problems. Some possible prolongations and restrictions are given, with modifications for both Dirichlet boundary conditions and Neumann boundary conditions. An algorithm for computing the Galerkin coarse grid approximation is given. ESA

**N93-17881#** Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France). Turbine Aero and Cooling Dept.
**THREE DIMENSIONAL INVISCID COMPRESSIBLE CALCULATIONS AROUND AXIAL FLOW TURBINE BLADES**
Antoine Fourmaux (Office National d'Etudes et de Recherches Aerospatiales, Paris, France ) and Bertrand Petot 1991 6 p Presented at 10th ISABE International Symposium on Air Breathing Engines, Nottingham, England, 1-6 Sep. 1991 Previously announced in IAA as A91-56154 Sponsored by Direction de Recherches, Etudes et Techniques, and Service Technique des Programmes Aeronautiques
(DS-2159; ETN-93-93381) Avail: CASI HC A02/MF A01

The application of a three dimensional (3D) method to the prediction of steady inviscid compressible flows in highly loaded stator bladings is presented. The complete set of Euler equations is solved by a finite difference method using a time marching two step Lax-Wendorff algorithm. The treatment of the boundary conditions is based on the use of the characteristic relations. This technique offers a great versatility and allows to prescribe conditions close to the physics of flows encountered in turbomachines. The code was adapted in order to build a 3D design tool able to run in different types of turbine blade geometries. Two types of multidomain structured meshes were tested (H+O+H and H+C). The H+C type of grid was finally choosen for industrial applications. Two applications to turbine nozzles are presented. The first is a low pressure turbine vane with evolutive flow path outer diameter. The results demonstrate the ability to predict flow features that cannot be computed via the classical two dimensional approach. The second is a high pressure inlet guide vane at transonic conditions. The strong radial evolution of pressure distribution and the trailing edge flow pattern are correctly predicted. ESA

**N93-17908#** Ohio State Univ., Columbus. Dept. of Engineering Mechanics.
**ON THE BEHAVIOR OF NON-NEWTONIAN FLUIDS: ANALYSIS, COMPUTATION, AND EXPERIMENT Final Report, 1 Apr. - 30 Sep. 1992**
M. G. Forest 30 Sep. 1992 3 p
(Grant AF-AFOSR-0253-90)
(AD-A258177; AFOSR-92-0954TR) Avail: CASI HC A01/MF A01

Significant progress has been achieved on key research projects that were supported by this grant. The researchers have extended the asymptotic modeling of free surface jets, through an averaging approach, to all orders in perturbation. These higher order theories were then extended to pointwise approximations, which yield more detailed characteristics of the flow. Dynamical ill-posedness of these model equations was discussed. Fully time-dependent model simulations were developed. Practical applications of these models were given for fiber spinning processes. Through interactions with government and private industry they have transferred this basic research to important applied problems. GRA

**N93-17925*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**PREDICTION OF RIGID SILICA BASED INSULATION CONDUCTIVITY**
Stanley D. Williams (Lockheed Engineering and Sciences Co., Houston, TX.) and Donald M. Curry Jan. 1993 132 p
(RTOP 551-74-11-31)
(NASA-TP-3276; S-687; NAS 1.60:3276) Avail: CASI HC A07/MF A02

A method is presented for predicting the thermal conductivity of low density, silica based fibrous insulators. It is shown that the method can be used to extend data values to the upper material temperature limits from those obtained from the test data. It is demonstrated that once the conductivity is accurately determined by the analytical model the conductivity for other atmospheres can be predicted. The method is similar to that presented by previous investigators, but differs significantly in the contribution due to gas and internal radiation. Author

**N93-18040** ESDU International Ltd., London (England).
**SELECTION AND COSTING OF HEAT EXCHANGERS**
Dec. 1992 68 p
(ESDU-92013; ISBN-0-85679-818-5) Avail: ESDU

ESDU 92013 gives guidance on the selection of heat exchanger types for a given duty against various criteria; they include the general characteristics, together with such detailed aspects as the ranges of pressure and temperature appropriate, compatibility with the fluids involved, space and weight requirements, and cleaning accessibility and maintenance. That allows an initial choice to be made from 18 principal types of exchangers. The various types are all illustrated. A final choice can then be made between the feasible types on the basis of costs. Detailed costing data provided by manufacturers are tabulated as a function of heat load, operating pressure and the types of cold- and hot-side fluids for the following types of exchangers: shell-and-tube, double-pipe, printed-circuit, plate-fin, air-cooled and welded plate. Costing data are also tabulated as a function of heat load and the types of cold- and hot-side fluids for gasketed-plate exchangers. Seven worked examples of selection based on technical suitability and

using the tabulated cost data illustrate fully the use of the information.
ESDU

**N93-18093*#** Computational Mechanics Co., Austin, TX.
**H-P ADAPTIVE METHODS FOR FINITE ELEMENT ANALYSIS OF AEROTHERMAL LOADS IN HIGH-SPEED FLOWS**
H. J. Chang, J. M. Bass, W. Tworzydlo, and J. T. Oden Jan. 1993 290 p
(Contract NAS1-18746; RTOP 506-40-21)
(NASA-CR-189739; TR-92-12; NAS 1.26:189739) Avail: CASI HC A13/MF A03

The commitment to develop the National Aerospace Plane and Maneuvering Reentry Vehicles has generated resurgent interest in the technology required to design structures for hypersonic flight. The principal objective of this research and development effort has been to formulate and implement a new class of computational methodologies for accurately predicting fine scale phenomena associated with this class of problems. The initial focus of this effort was to develop optimal h-refinement and p-enrichment adaptive finite element methods which utilize a-posteriori estimates of the local errors to drive the adaptive methodology. Over the past year this work has specifically focused on two issues which are related to overall performance of a flow solver. These issues include the formulation and implementation (in two dimensions) of an implicit/explicit flow solver compatible with the hp-adaptive methodology, and the design and implementation of computational algorithm for automatically selecting optimal directions in which to enrich the mesh. These concepts and algorithms have been implemented in a two-dimensional finite element code and used to solve three hypersonic flow benchmark problems (Holden Mach 14.1, Edney shock on shock interaction Mach 8.03, and the viscous backstep Mach 4.08). Author

**N93-18094#** Societe Europeenne de Propulsion, Vernon (France). Dept. of Turbomachinery.
**EXPERIMENTAL INVESTIGATIONS OF RADIAL LOADS INDUCED BY PARTIAL CAVITATION WITH THE LH2 VULCAIN INDUCER**
B. Goirand, A. L. Mertz, F. Joussellin (Institut National Polytechnique, Grenoble, France ), and C. Rebattet (Institut National Polytechnique, Grenoble, France ) 1992 12 p Presented at the 3rd International Conference on Cavitation, Cambridge, England, 9-12 Dec. 1992
(ETN-93-93023) Avail: CASI HC A03/MF A01

Radial forces generated by partial cavitation were investigated both in water and liquid hydrogen (LH2) with the four bladed inducer of the Vulcain liquid hydrogen turbopump. A specific shaft mounted six component balance was developed for inducer water tests, in which force measurements were completed by unsteady pressure measurements and high speed flow visualizations. From water results, a good qualitative agreement with previous experiences was obtained but the influence of blade number was demonstrated. Characteristic frequencies of unsteady cavitation phenomena were identified at different operating points. The force measurements in hydrogen gave promising results about thermodynamics delay, in the scope of establishing transposition rules. ESA

**N93-18096#** Ecole Centrale de Lyon (France). Lab. de Mechanique des Fluides et d'Acoustique.
**CONTRIBUTION TO THE SOLUTION OF MOMENT EQUATIONS AT TWO POINTS BY THE SPECTRAL INTEGRAL METHODS Ph.D. Thesis [CONTRIBUTION A LA RESOLUTION DES EQUATIONS DES MONENTS EN DEUX POINTS PAR METHODE INTEGRALE ET SPECTRALE]**
Mohammed Oucamah CherkaouiMalki 1992 161 p In FRENCH
(ECL-92-19; ETN-93-93025) Avail: CASI HC A08/MF A02

A method to study turbulent flow is proposed. The purpose of the study is a better understanding of the mechanisms involved in wall bounded turbulent flows. The characteristics and the evolution of the turbulent flow between two parallel walls is analyzed. The statistical model equations are applied and a modified Green equation was developed to correlate and describe the flow between two points. The feasibility of applying integral spectral methods, first to an inhomogeneous flow between the two walls and second to the linearization of this problem is investigated. The steps of the investigation are: description of the flow equations; a new formulation of the Navier-Stokes equations; characterization of flat channel flow and the flow between two walls; spectral correlation equations and validation of the equations by numerical methods; and one dimensional spectral field approximation. The results show that the pressure distribution limits the use of linear approximation methods to describe wall bounded flows. The solution method developed in the study can be applied to solve problems of high geometrical complexity. ESA

**N93-18103#** Manchester Univ. (England). Aeronautical Engineering Group.
**MODELLING OF INTERFACIAL AND THERMOCLINE WAVES Quarterly Progress Report No. 5**
D. Nicolaou, F. A. Paonessa, and T. N. Stevenson 1992 12 p Sponsored by Ministry of Defence
(Aero-Rept-9209; ETN-93-93009) Avail: CASI HC A03/MF A01

Progress of the theory and of experimental work is given. A program for a body moving in an enclosed region surrounded by solid walls was completed. Finite difference results obtained from this program can be used to compare with experimental results of thermocline waves. Numerical investigations surrounding the implementation of open boundary conditions in the present finite difference program are considered. In the experimental investigation, preliminary runs towing the boat model to investigate its drag characteristics in different thermocline thicknesses are considered. The model was first towed in a tank of freshwater to give a baseline for the drag variation with speed. A graph of drag against speed for varying model configurations is given. The variation of drag with speed for different thermocline thicknesses is shown as the interface was allowed to diffuse with time. ESA

**N93-18104#** Manchester Univ. (England). Aeronautical Engineering Group.
**MODELLING OF INTERFACIAL AND THERMOCLINE WAVES Quarterly Progress Report No. 6**
D. Nicolaou, F. A. Paonessa, and T. N. Stevenson 1992 11 p Sponsored by Ministry of Defence
(Aero-Rept-9210; ETN-93-93010) Avail: CASI HC A03/MF A01

The tracking of particles at a given level in a tank as they are moved by internal waves generated by a moving submerged body is considered. The most suitable particles were found to be polystyrene beads. The thermocline was produced by letting an interface diffuse. By choosing the density of the brine above and below the interface the particles could be made to settle at any given position relative to the center of the thermocline. Two graduated perspex bars were supported over the tank in the field of view to give the position and scale. The optics were designed so that there was a large depth of focus at the working section. The position of these scales in the tank and also the position of the model are illustrated. The model was towed along the tank and the motion of the particles was recorded on video tape. After the run, the video was played into a digitizing board on the Archimedes computer. Particle path during a run is illustrated. Photographs of the wave system when the body is moving above the centerline of the thermocline are given. Further results of the program for a rectangular body moving in a region enclosed by walls are given showing constant density perturbations and velocity vectors. ESA

**N93-18105#** Manchester Univ. (England). Aeronautical Engineering Group.
**MODELLING OF INTERFACIAL AND THERMOCLINE WAVES Quarterly Progress Report No. 7**
D. Nicolaou, F. A. Paonessa, and T. N. Stevenson 1992 24 p Sponsored by Ministry of Defence
(Aero-Rept-9211; ETN-93-93011) Avail: CASI HC A03/MF A01

A turbulent wake was generated using a small grid in the end of a strut. This was followed by many runs with small streamlined axisymmetric bodies and it was concluded that the wave systems are those described by the 'plan view theory' (P1) outlined in the first progress report. Wave shapes from P1 for three body speeds for one particular thermocline are shown. Only the first three modes are shown corresponding to a body moving along the center of the thermocline. Theory and experiment for the even modes when the body travels along the center of the thermocline are compared. Figures of conductivity probe measurements showing profiles of density with time are given. An update on the finite density program is given. ESA

**N93-18106#** Manchester Univ. (England). Aeronautical Engineering Group.

**MODELLING OF INTERFACIAL AND THERMOCLINE WAVES Quarterly Progress Report No. 8**

D. Nicolaou, F. A. Paonessa, and T. N. Stevenson 1992 24 p Sponsored by Ministry of Defence

(Aero-Rept-9212; ETN-93-93012) Avail: CASI HC A03/MF A01

Improved open boundary conditions are compared with other types of open boundary conditions. The improved open boundary conditions were incorporated into the finite difference code and drag measurements taken for the case when the body is positioned against a solid upper wall with a thermocline just below it. Two body lengths were used. The body is fixed relative to a grid and a background flow is imposed. Four different methods of calculating the velocities at boundaries were tested and are discussed. Experimental work in surface ships moving over thermoclines is considered. It is stated that for a non stratified case, the drag is proportional to the velocity squared so it can be seen that the effect of stratification is to cause a peak in the drag curve. The aim of the experiment was to determine the effects of different thermocline thicknesses and density differences and to understand in depth the cause of this drag peak. ESA

**N93-18119#** Manchester Univ. (England). Aeronautical Engineering Group.

**MODELLING OF INTERFACIAL AND THERMOCLINE WAVES Quarterly Progress Report No. 9**

D. Nicolaou, F. A. Paonessa, and T. N. Stevenson 1992 8 p Sponsored by Ministry of Defence

(Aero-Rept-9213; ETN-93-93013) Avail: CASI HC A02/MF A01

The finite difference code with improved boundary conditions is considered. An illustration of a body next to a solid upper boundary with a thermocline just below it is presented. Another diagram shows the instantaneous velocity vectors in planes looking upstream along the body path. Further diagrams illustrating a free surface calculation show: the free surface displacement along its centerline, free surface shape, side view of perturbation velocity vectors in the central vertical plane, and an upstream view of perturbation velocity vectors in a plane immediately aft of the body. ESA

**N93-18121#** Pennsylvania State Univ., University Park. Applied Research Lab.

**EXPERIMENTAL ANALYSIS OF THE AEROACOUSTICS OF CASCADED AIRFOILS**

L. A. Perry and G. C. Lauchle Nov. 1992 99 p

(AD-A257945; PSU/ARL-TR-92-08) Avail: CASI HC A05/MF A02

The purpose of this study is to investigate the noise radiated by various louver designs. A louver is essentially a cascade of small airfoils, operating at the same angle of attack. Louvers are commonly used in heating, ventilation, and air conditioning (HVAC) systems to provide directional control of the exit airflow. The HVAC system of an automobile can be a significant source of acoustic annoyance. Louvers are typically placed in the near field of the driver and passenger and can be major contributors to the overall interior noise level. In this study, thirteen representative dashboard registers used in automotive HVAC applications are considered. These registers vary in airfoil shape, number of airfoils, number of support struts, inlet and outlet sizes, and other physical parameters. The research documented in this thesis is directed toward a better understanding of the parameters that significantly affect the amount of noise generated by a louver. GRA

**N93-18129#** Manchester Univ. (England). Aeronautical Engineering Group.

**COMPUTATIONAL STUDY OF REAL GAS EFFECTS IN HIGH SPEED HIGH TEMPERATURE FLOW Annual Report, 1990**

S. Shahpar, I. M. Hall, and D. I. A. Poll 1991 247 p

(Contract SMD097865)

(Aero-Rept-9102; ETN-93-93000) Avail: CASI HC A11/MF A03

Several hypersonic flow problems which lead towards the ultimate goal of computing the flow round a reentry vehicle were considered. At this stage, the investigation was compartmentalized so that the difficulties connected with different aspects of the problem could be investigated separately. Both equilibrium and nonequilibrium flows are considered. Since code validation is extremely important, several simple and well documented flows were used as test cases. Using an equilibrium air model some hypersonic blunt body flows were computed. Nonequilibrium flows introduce stiffness problems which were dealt with by designing a point implicit TVD method. The algorithm was successfully applied to configurations which are shortly to be tested in a shock tunnel. Validation of the latter code will be made as soon as the experimental results are available. An extensive literature survey on flows with finite rate chemistry, including equilibrium flows, is included as well as different treatments for avoiding stiffness due to chemical source terms. ESA

**N93-18130#** Manchester Univ. (England). Aeronautical Engineering Group.

**HIGH SPEED LAMINAR FLOW OVER CAVITIES**

D. R. Emerson (Science Research Council, Daresbury, England ) and D. I. A. Poll 1991 17 p Sponsored by RAE

(Aero-Rept-9110; ETN-93-93001) Avail: CASI HC A03/MF A01

The explicit MacCormack finite volume method, with a Total Variation Diminishing (TVD) scheme for stability, was used to solve the Navier-Stokes equations to simulate the flow over rectangular cavities. The computations indicated that the oscillatory frequencies are essentially independent of wall temperature, stagnation temperature, boundary layer thickness at separation, and unit Reynolds number. However, the magnitude of the pressure fluctuations depends strongly on the wall temperature and boundary layer thickness at separation. ESA

**N93-18132#** Manchester Univ. (England). Aeronautical Engineering Group.

**ANALYTICAL SURFACE SINGULARITY DISTRIBUTIONS FOR FLOW ABOUT ELLIPTICAL CYLINDERS**

P. G. Bellamy-Knights Mar. 1992 12 p

(Aero-Rept-9202; ETN-93-93003) Avail: CASI HC A03/MF A01

Analytical solutions for flows past elliptical cylinders were investigated in an attempt to provide bench mark solutions. It was found that for elliptic cylinders, vorticity distributions can, in general, easily be obtained and this was illustrated in detail for the case of a discrete line source at a general location outside the elliptic cylinder. On the other hand, no general method of obtaining source/sink distributions could yet be discerned. One new source/sink solution, however, was obtained, namely for a uniform flow at incidence to the major axis of the ellipse. This should provide a useful benchmark test case for source/sink panel method algorithms which does not involve so much symmetry as to lead to error cancellation in the corresponding numerical solutions. ESA

**N93-18133#** Manchester Univ. (England). Aeronautical Engineering Group.

**WALL STRAINS PRODUCED BY WAVES IN WATER FILLED LATEX TUBES. PART 1: TETHERED TUBES Progress Report**

J. H. Gerrard May 1992 27 p Presented at Euromech Colloquim 286 on Three Dimensional Blood Flow in Bifurcations, Kerkrade, Netherlands, 20-23 Oct. 1991

(Aero-Rept-9206-Pt-1; ETN-93-93006) Avail: CASI HC A03/MF A01

A progress report on measurements of wall strain is presented. The experimental aim is to produce data with which to compare the results of numerical analysis of pulsatile flow in a deformable tube. The computation is a difficult job requiring the solution of the wall and fluid equations and matching them at the interface which moves. The simplest arrangement of a straight distensible tube attached to a rigid tube of the same internal diameter in which a piston starts from rest was consequently chosen. The rubber tube is of finite length and closed and fixed at the far end. Two forms of motion are examined, sinusoidal motion from rest and impulsive motion in which the piston moves a short distance and stops. The simpler case considered is a tethered tube which only executes radial motion; in the second case the horizontal tube is suspended by cotton threads so that it is free to move longitudinally as well. Measurements of the longitudinal and circumferential strains as a function of distance along the tube were made. The measurements were made at low and high frequency and with short and long tubes. With long tubes the end effect can be investigated. The treatment of shorter tubes by numerical analysis present less of a storage problem. ESA

**N93-18134#** Manchester Univ. (England). Aeronautical Engineering Group.

**WAVES FROM AN OSCILLATING DISTURBANCE IN A THERMOCLINE AND IN A LINEAR SHEAR FLOW**

R. Liu, D. Nicolaou, D. Kanellopulos, and T. N. Stevenson 1992 24 p Sponsored by Ministry of Defence

(Aero-Rept-9207; ETN-93-93007) Avail: CASI HC A03/MF A01

The way in which energy propagates away from a two dimensional oscillatory disturbance in a stratified fluid is considered. It is shown how the St. Andrew's cross wave is modified by reflections in a thermocline and how the cross wave can develop into thermocline waves. A linear shear flow was then superimposed on the thermocline. Ray theory was used to evaluate the wave shapes and these are compared with finite difference solutions of the full Navier-Stokes equations. ESA

**N93-18135#** Manchester Univ. (England). Aeronautical Engineering Group.

**THERMOCLINE WAVES FROM A MOVING BODY AND COMPARISON OF OPEN-BOUNDARY CONDITIONS**

D. Nicolaou and T. N. Stevenson 1992 13 p

(Aero-Rept-9208; ETN-93-93008) Avail: CASI HC A03/MF A01

A study directed at understanding the interactions between interfacial and thermocline waves is described. A three-dimensional finite difference program for time dependent flow simulation was developed which models the movement of a body in an enclosed stratified fluid. The movement of the body generates internal waves which agree with the phase configurations given by small amplitude ray theory. Some examples are shown in figures which present contours of constant density perturbation, surfaces of constant density perturbation, and instantaneous velocity vectors on side and plan views. There is a noticable change from one type of wave to another across the thermocline which is under investigation. ESA

**N93-18191#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

**CONTRIBUTION TO THE STUDY OF VORTEX FLOW IN AN INCOMPRESSIBLE FLUID Ph.D. Thesis - Strasbourg Univ. [CONTRIBUTION A L'ETUDE D'UN ECOULEMENT TOURBILLONNAIRE EN FLUIDE INCOMPRESSIBLE]**

Philippe Pascal 1992 206 p In FRENCH

(ONERA-NT-1992-4; ETN-93-93047) Avail: CASI HC A10/MF A03

Vortices can have large effects on the performance of aircraft flying at high angles of attack and missiles equipped with highly swept control surfaces. A theoretical study was conducted to develop a calculation method for predicting vortex flows. Different models used to determine how the vortex approaches breakdown were compared. These methods are based on the assumption of axisymmetry and on a conventional statistical treatment of the turbulence using closure in one point. The computations and experimental results were compared. An experimental study was conducted in a wind tunnel to qualify the influence of turbulence in the development of an unburst vortex. An arrangement producing a wing tip vortex was used. The internal structure of the vortex exhibited a velocity maximum in its center which decreased longitudinally. The external velocity field is represented by a potential vortex. The existence of lateral flow movements induced low frequency fluctuations which are superimposed on the turbulence. ESA

**N93-18215#** Wisconsin Univ., Madison. Center for Mathematical Sciences.

**SELF-SIMILAR FLUID DYNAMIC LIMITS FOR THE BROADWELL SYSTEM**

Marshall Slemrod and Athanasios E. Tzavaras Oct. 1992 60 p

(Contract DAAL03-88-K-0185)

(AD-A257950; CMSTR-93-6) Avail: CASI HC A04/MF A01

This report discusses a new approach for the resolution of the fluid dynamic limit for the Broadwell system of the kinetic theory of gases, appropriate in the case of Riemann, Maxwellian data. Since the formal limiting system is expected to have self-similar solutions, we are motivated to replace the Knudsen number E in the Broadwell model so that the resulting model admits self-similar solutions in E = x/t and then let E go to zero. The limiting procedure is justified and the resulting limit is a solution of the Riemann problem for the fluid dynamic limit equations. A class of Riemann data for which this program can be carried out is exhibited. Furthermore, it is shown that for the Carleman model the complete program can be done successfully for arbitrary Riemann data. GRA

**N93-18305#** Naval Postgraduate School, Monterey, CA.

**NUMERICAL ANALYSIS OF THE FLOW IN A TURBULATED RECTANGULAR DUCT SIMULATING THE COOLING PASSAGES IN A TURBINE BLADE M.S. Thesis**

Robert M. Palatka 15 Jun. 1992 93 p

(AD-A257855) Avail: CASI HC A05/MF A01

An extensive review of the literature revealed that many experimental studies have been conducted in heat-transfer wind tunnels simulating the cooling passages in turbine blades. However, very few numerical studies have been performed. Phoenics, a computational fluid dynamics computer program, produced results for several duct configurations and calculated the heat transfer characteristics of each. The configurations investigated included a straight, square duct and a rectangular duct with turbulators, (a form of turbulence promoter) present. The parameters varied included Reynolds number, turbulence intensity, and grid geometry. Results for the turbulated duct indicated highly distinct and repeatable flow patterns developed over a wide range of values. The variation of the inlet turbulence intensity had little impact on the kinetic energy. The results proved to be highly grid dependent, which greatly impacted the correlation between experimentally and numerically produced data, for the same configurations, under similar operating parameters. GRA

**N93-18326#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

**DIRECT SIMULATION OF EXTERNAL SEPARATED FLOW WITH THE 3-D NAVIER-STOKES EQUATIONS Ph.D. Thesis - Paris VI Univ., 1991 [SIMULATION DIRECTE D'ECOULEMENTS EXTERNES DECOLLES PAR RESOLUTION NUMERIQUE DES EQUATIONS DE NAVIER-STOKES TRIDIMENSIONNELLES]**

Bruno Troff 1992 148 p In FRENCH

(ONERA-NT-1992-6; ETN-93-93049) Avail: CASI HC A07/MF A02

Two dimensional and three dimensional direct simulation of an unsteady, incompressibie, strongly separated, external viscous flow is performed. Navier-Stokes equations are written in velocity-pressure formulation. A curvilinear coordinate system is introduced. Cartesian velocity components are retained as unknowns. Governing equations are discretized using second order time and space finite difference schemes in a non staggered grid. Pressure is computed by solving a Poisson like equation by minimizing a norm of the velocity divergence. An implicit residual smoothing operator relieves the Courant-Friedrichs-Levy restrictions. Applications to two dimensional flow, behind a circular cylinder and around an airfoil at high angle of attack, are achieved. Three dimensional results are related to the flow around a circular cylinder and around an airfoil between two walls. Comparisons with experimental data are made. ESA

**N93-18347#** Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.

**DROP/GAS INTERACTIONS IN DENSE SPRAYS Final Report, 15 Aug. 1989 - 14 Aug. 1992**

L.-P. Hsiang, J.-S. Wu, M. Mizukami, and G. M. Faeth 30 Sep. 1992 117 p

(Grant AF-AFOSR-0516-89)

(AD-A257848; AFOSR-92-0961TR) Avail: CASI HC A06/MF A02

This is a final report of research considering three types of drop/gas interactions that are important. In the near-injector, dense region of sprays, namely: (1) secondary drop breakup, which is an intrinsic outcome of primary breakup and is the most significant rate process of dense sprays; (2) turbulence generation by dispersed phases, which is the most significant source of turbulence production within dense sprays; and (3) the structure of sphere wakes at moderate Reynolds numbers, which is a fundamental property needed to understand turbulence generation. The properties of secondary breakup were observed for shock wave initiated disturbances in air at normal temperature and pressure, using pulsed shadowgraphy and holography to measure the dynamics and outcome of breakup and theories phenomenological theories to interpret and correlate the measurements. Particle-generated turbulence was observed using uniform fluxes of spherical particles falling through (in the mean) air, using phase-discriminating laser velocimetry to measure flow properties and stochastic analysis to interpret

and correlate the measurements. The properties of sphere wakes at moderate Reynolds numbers were observed in both nonturbulent and turbulent environments, using laser velocimetry to measure flow properties and similarity theories to interpret and correlate the results. GRA

**N93-18416#** Brown Univ., Providence, RI.
**INVESTIGATION OF WALL BOUNDED TURBULENCE: COHERENCE AND CHAOS IN A MODEL OF TURBULENT BOUNDARY-LAYER Final Report**
Nov. 1991 5 p
(Contract N00014-91-J-1588)
(AD-A257794) Avail: CASI HC A01/MF A01

The research results from three projects investigating wall bounded turbulence are summarized. The topics covered include the following: coherence and chaos in a model of a turbulent boundary-layer; modeling a no-slip flow boundary with an external force field; and drag reduction in turbulent channel flow by phase randomization. Author

**N93-18440#** Sheffield Univ. (England). Dept. of Automatic Control and Systems Engineering.
**IDENTIFICATION OF NONLINEAR WAVE FORCES. PART 2: FREQUENCY-DOMAIN ANALYSIS**
K. Worden (Manchester Univ., England ), P. K. Stansby (Manchester Univ., England ), G. R. Tomlinson (Manchester Univ., England ), and S. A. Billings Oct. 1991 46 p Sponsored by Health and Safety Executive
(RR-442-Pt-2; ETN-92-92769) Avail: CASI HC A03/MF A01

The Nonlinear Autogressive Moving Average model with exogeneous inputs (NARMAX) system identification technique is applied to a number of fluid loading datasets. The aim is to determine if there exists a simple extension of Morison's equation to predict forces with improved accuracy. In part 2, the results obtained in the frequency domain are described. The Volterra representation of a nonlinear system is given. How one can obtain the higher order frequency response functions from the system equation of motion, (or its NARMAX representation) using the method of harmonic probing, is demonstrated. The validation and interpretation of the higher order frequency response functions are addressed. The harmonic probing procedure is applied to Morison's equation. The higher order frequency response functions for the NARMAX models, from the time domain analysis, are obtained and it is shown that they exhibit a number of common features. The results presented are not original. However, as the determination of higher order frequency response functions by harmonic probing is unlikely to be a well known technique within the context of fluid loading calculations, a review is given in order to make the paper essentially self-contained. ESA

**N93-18510#** Sheffield Univ. (England). Dept. of Automatic Control and Systems Engineering.
**IDENTIFICATION OF NONLINEAR WAVE FORCES. PART 1: TIME DOMAIN-ANALYSIS**
K. Worden (Manchester Univ., England ), P. K. Stansby (Manchester Univ., England ), G. R. Tomlinson (Manchester Univ., England ), and S. A. Billings Oct. 1991 52 p Sponsored by Health and Safety Executive
(RR-441-Pt-1; ETN-92-92768) Avail: CASI HC A04/MF A01

The Nonlinear Autoregressive Moving Average model with exoneous inputs (NARMAX) system identification technique is applied to a number of fluid loading data sets. The aim is to determine if there exists a simple extension of Morison's equation to predict forces with improved accuracy. In part 1, concerned with time domain results, a number of NARMAX time series models are obtained for a range of situations of wave loading on slender cylinders. An introduction to system identification using the NARMAX nonlinear time series analysis procedures is provided. The basic theory required for any parameter estimation problem is summarized. The problem of determining the appropriate form for the system model is discussed. The model validation is presented. A simulation of a Morison type system is used to demonstrate the utility of the NARMAX procedures in analyzing fluid loading data. The results of applying the techniques to experimental data measured in a U-tube are discussed. Unidirectional random waves in a large flume are analyzed. Data from a directional random sea is discussed. ESA

**N93-18529#** Los Alamos National Lab., NM.
**UNDERSTANDING CURVED DETONATION WAVES**
B. G. Bukiet (New Jersey Inst. of Tech., Newark.) and R. Menikoff 1992 4 p Presented at the 10th Detonation Symposium, Boston, MA, Jul. 1992
(Contract W-7405-eng-36)
(DE93-000799; LA-UR-92-2915; CONF-9207159-1) Avail: CASI HC A01/MF A01

A wave curve is the set of final states to which an initial state may be connected by a traveling wave. In gas dynamics, for example, the wave curve consists of the shock Hugoniot curve for compressive waves and the rarefaction curve for expansive waves. In this paper, we discuss the wave curve for an undriven planar detonation and for general planar detonations. We then extend the wave curve concept to detonations in converging and diverging geometry. We also discuss the application of these wave curves to the numerical computation of detonation problems. DOE

**N93-18540#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**COMPUTATIONAL FLUID DYNAMICS, VOLUME 1**
1992 395 p Lecture series held in Rhode-Saint-Genese, Belgium, 23-27 Mar. 1992 Original contains color illustrations
(VKI-LS-1992-04-Vol-1; ETN-92-92361) Copyright Avail: CASI HC A17/MF A04

In-depth presentations on well established methods and on recent advances in the field of numerical flow simulation are presented. Three papers are presented which discuss the following: applied grid generation for complex domains in two- and three-dimensions; solution of time dependent incompressible Navier-Stokes equations by finite elements; and finite element modeling of fluids. For individual titles, see N93-18541 through N93-18543.

**N93-18541#** European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
**APPLIED GRID GENERATION FOR COMPLEX DOMAINS IN 2 AND 3 DIMENSIONS**
J. Haueser, Hans-Georg Paap (Genias G.m.b.H., Weidenberg, Germany ), and M. Spel (Xicom, Weesp, Netherlands ) *In* VKI, Computational Fluid Dynamics, Volume 1 1992 86 p Original contains color illustrations
(For primary document see N93-18540 06-34)
Copyright Avail: CASI HC A05/MF A04

Numerical grid generation is presented in a way that is understandable to the scientist and engineer who is more a programmer than a mathematician. Emphasis is on how to write a grid generation package. Algorithms and data structures are presented from the Grid(star) package. Focus is on grid generation design concepts. Grid generation on parallel computers is discussed. Since grid generation is a means to solve problems in computational dynamics and related fields, interfacing the final grid to the Euler or Navier-Stokes solver is considered. Although, in general, generated grids are slope continuous, higher order solvers need overlaps of two points in each direction. The software to generate this overlap for multiblock grids is presented. The grid generation process is explained and demonstrated for several two-dimensional examples. In three dimensions a start is made with a simple monoblock grid for the double ellipsoid, explaining the mapping procedure in three dimensions. After that, a multiblock grid is shown, removing the singular line at the nose. Surface grid generation for the Hermes Spaceplane is demonstrated, and subsequently, a mono and a four block grid are generated. The Space Shuttle Orbiter is also presented where surface grid generation is given for a 4 block grid, modeling a somewhat simplified Orbiter geometry, namely a Shuttle without body flap. The surface grid and volume grid for the 94 block Euler mesh of a Shuttle with body flap are presented. The rationale for the choice of that topology is carefully explained. ESA

**N93-18542#** Politecnico di Milano (Italy).
**SOLUTION OF THE TIME-DEPENDENT INCOMPRESSIBLE NAVIER-STOKES EQUATIONS BY FINITE ELEMENTS**
L. Quartapelle *In* VKI, Computational Fluid Dynamics, Volume 1 1992 159 p (For primary document see N93-18540 06-34)
Copyright Avail: CASI HC A08/MF A04

Boundary conditions in incompressible viscous problems are addressed and an attempt is made to provide a unitary framework for its analysis. Attention is focussed mainly on the time dependent equations and on

formulations in which the incompressibility condition is imposed by means of a Poisson equation for a scalar or vector unknown. In other terms, the general theme of enforcing the continuity equation in incompressible fluid dynamics by solving an equivalent substitute equation which involves the Laplace operator, is discussed. In particular, the full set of conditions required to supplement the parabolic and elliptic equations occurring in the different representations are determined. so as to obtain uncoupled formulations of the incompressible equations. A generalization of the idea of the pressure integral conditions to the case of the unsteady Stokes problem with a continuous time dependence is considered. The analysis of the various formulations and the corresponding numerical schemes are developed mainly in view of spatial approximations based on the finite element method and using unstructured grids. ESA

**N93-18543#** Universite de Technologie de Compiegne (France).
**FINITE ELEMENT MODELING OF FLUIDS**
G. Dhatt *In* VKI, Computational Fluid Dynamics, Volume 1 1992 143 p (For primary document see N93-18540 06-34)
Copyright Avail: CASI HC A07/MF A04

Basic mathematical operations are presented. Mathematical models written in strong and weak forms for fluid flow problems are presented. Fluid flow models in variational or weak forms are discussed. The finite element approximations are employed to obtain the flow models in algebraic forms. Solution methods for incompressible flows, with an explicit coupling with an advection-diffusion model of temperature or any other scalar quantity, are considered. Some aspects of simulating moving fronts of metal flow during mould filling are considered. Some aspects of finite element modeling related to free surface hydraulic flows are presented. ESA

**N93-18563#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**COMPUTATIONAL FLUID DYNAMICS, VOLUME 2**
1992 265 p Lecture series held in Rhode-Saint-Genese, Belgium, 23-27 Mar. 1992
(VKI-LS-1992-04-Vol-2; ETN-92-92362) Copyright Avail: CASI HC A12/MF A03

Three papers are presented. The following topics are discussed: the validation of central and upwind three dimensional compressible flow solvers; the development and numerical solution of Parabolized Navier-Stokes (PNS) equations; and the development of a streamwise upwind algorithm for appliciation to aerodynamics and aeroelasticity. For individual titles, see N93-18564 through N93-18566.

**N93-18564#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**VALIDATION OF CENTRAL AND UPWIND 3D COMPRESSIBLE FLOW SOLVERS**
M. Manna *In its* Computational Fluid Dynamics, Volume 2 62 p(SEE N93-18563 06-34) 1992 (For primary document see N93-18563 06-34)
Copyright Avail: CASI HC A04/MF A03

The difficult task of choosing a numerical method that can accurately and efficiently solve Euler equations is discussed while remaining aware of the fact that the practical importance of Euler equations in the context of real flows is limited, although not negligible. Emphasis is given to techniques which can properly handle the strong discontinuities (shock waves and contact discontinuities) typical of high speed flows. Different numerical methods (central and upwind) are compared on the basis of well defined test cases. Performances of the 'state of art' algorithms which can presently be used and coded for real engineering applications are evaluated. Fundamental work in algorithm development, which is inspired by the limitations of the available methods, is discussed and preliminary results on standard two dimensional (2D) test cases are presented. A detailed comparison of numerical results obtained for two test cases in delta wing geometries is presented. A comparison between computations with independently developed upwind Euler solvers are presented using identical grids. Several published results by other authors, based on both upwind and central discretization, are also compared. ESA

**N93-18565*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PARABOLIZED NAVIER-STOKES METHODS FOR HYPERSONIC FLOWS**
S. L. Lawrence *In* VKI, Computational Fluid Dynamics, Volume 2 1992 114 p (For primary document see N93-18563 06-34)
Copyright Avail: CASI HC A06/MF A03

The development and numerical solution of the Parabolized Navier-Stokes (PNS) equations is discussed. Special emphasis is placed on numerical integration algorithms for PNS solvers, most notably recent applications of upwind schemes. Application of this technology to high speed, high Reynolds number flows was the focus, and modeling techniques for real gas effects and turbulence were discussed. Experiences in validating the UPS upwind PNS flow solver for relatively simple body shapes are presented. The test cases range in complexity from two dimensional perfect gas cases to three dimensional finite rate chemistry cases. ESA

**N93-18566*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**ALGORITHM DEVELOPMENT WITH APPLICATIONS TO AERODYNAMICS AND AEROELASTICITY**
P. M. Goorjian, S. Obayashi, N. M. Chaderjian, and G. P. Guruswamy *In* VKI, Computational Fluid Dynamics, Volume 2 1992 81 p (For primary document see N93-18563 06-34)
Copyright Avail: CASI HC A05/MF A03

The development of a streamwise upwind algorithm is presented. Applications of this algorithm to steady flow over a delta wing and unsteady flow over an oscillating wing, respectively, are covered. An extension to higher order accuracy for upwind methods is discussed. This scheme will use the compatibility relations for the extension. The use of multiple zones in the calculation of unsteady flows is considered. Multiple zones are one way to treat complex configurations, such as complete aircraft. Aeroelastic calculations are discussed. A procedure for aeroelastic calculations is described that simultaneously solves the aerodynamic and structural equations of motion. Sample calculations are given to illustrate the above. ESA

**N93-18581#** European Space Agency, Paris (France).
**NUMERICAL SIMULATION AND STABILITY ANALYSIS OF THE ABSOLUTELY AND CONVECTIVELY UNSTABLE WAKE [NUMERISCHE SIMULATION UND STABILITAETSDTHEORETISCHE UNTERSUCHUNG DES ABSOLUT UND KONVEKTIV INSTABILEN NACHLAUFS]**
Klaus Hannemann Jan. 1990 126 p Transl. into ENGLISH of German report no. DFVLR-FB-88-09 Original language document was announced as N88-27518 Document prepared by DFVLR, Goettingen, Germany
(ESA-TT-1119; DFVLR-FB-88-09) Avail: CASI HC A07/MF A02

The wake behind a flat plate, held parallel to the free-stream, is simulated numerically by using a finite difference Galerkin method for the solution of the time dependent, incompressible Navier-Stokes equations. The way in which perturbations are amplified with time at supercritical Reynolds numbers - leading finally to the saturation state - is the major center of interest. The Orr-Sommerfeld stability analysis of the quasi-steady state occurring during the wake development reveals that the flow can be divided into a locally absolutely unstable and a locally convectively unstable region. The influence of these stability properties on the wake, as well as their variation with Reynolds number and base bleed is discussed on the basis of the numerical simulation and the linear, local stability analysis. Author

**N93-18604*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**HYPERSONIC RAREFIED WAKE CHARACTERIZATION**
E. B. Brewer Washington Jan. 1993 25 p
(NASA-TP-3327; M-711; NAS 1.60:3327) Avail: CASI HC A03/MF A01

Results of a numerical study using the direct simulation Monte Carlo (DSMC) method are presented for hypersonic rarefied flow over an aeroassisted space transfer vehicle (ASTV). The emphasis of the study is the characterization of the near wake region which includes the ASTV payload. The study covered the transitional flow regime from near continuum to free molecular. Calculations show that the character of the near wake is significantly affected by the presence of the payload. Flow separation occurs when an afterbody is present throughout the transitional flow regime. In contrast, when no afterbody is present, no separation is observed until the flow approaches continuum. Author

**N93-18622#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 6: Calcul Scientifique, Modelisation et Logiciels Numeriques.

**ON THE NUMERICAL APPROXIMATION OF THE k-EPSILON TURBULENCE MODEL FOR TWO DIMENSIONAL COMPRESSIBLE FLOWS [APPROXIMATION NUMERIQUE DU MODELE DE TURBULENCE K-EPSILON POUR DES ECOULEMENTS COMPRESSIBLES BIDIMENSIONNELS]**

Christian Olivier and Bernard Larrouturou Sep. 1991 37 p
(Contract DRET-88-217)
(INRIA-RR-1526; ETN-93-92661) Avail: CASI HC A03/MF A01

A numerical method for solving the k-epsilon turbulent model without 'wall law' for two dimensional compressible flows is presented. This method combines an upwind finite volume approximation for the inviscid terms and a centered finite element for the viscous terms and the source term. As an illustration of the method, the test case of a compressible subsonic mixing layer is presented. ESA

**N93-18623#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 6: Calcul Scientifique, Modelisation et Logiciels Numeriques.

**EXACT-GRADIENT SHAPE OPTIMIZATION OF A 2D EULER FLOW [OPTIMISATION DE PROFILS PAR UNE METHODE DE GRADIENT EXACT POUR UN ECOULEMENT 2D EULERIEN]**

Francois Beux and Alain Dervieux Oct. 1991 34 p
(Contract BRITE/EURAM-1082)
(INRIA-RR-1540; ETN-93-92662) Avail: CASI HC A03/MF A01

The optimization of an obstacle shape put into a 2D (two dimensional) Euler flow is addressed. In order to apply a descent method, the differentiation of the flow solution is considered with respect to the shape. In the continuous case, the derivatives (Hadamard variational formula) are formally constructed. In the discrete case, an upwind method with flux splitting is chosen, and an exact gradient is proved to be computable using adjoint state. The behavior of a gradient method is studied for a family of nozzle flows. ESA

**N93-18629#** Technische Univ., Brunswick (Germany). Fakultaet fuer Maschinenbau und Elektrotechnik.

**A GENERAL APPROXIMATION SOLUTION FOR THE MASS TRANSFER IN LAMINAR MULTICOMPONENT BOUNDARY LAYERS ALONG A STREAMING PLATE PLANE Ph.D. Thesis [ALLGEMEINE NAEHERUNGSLOESUNG FUER DEN STOFFAUSTAUSCH IN LAMINAREN MEHRSTOFFGRENZSHICHTEN AN DER LAENGS ANGESTROEMTEN, EBENEN PLATTE]**

Soenke Broecker 1991 117 p In GERMAN
(ETN-93-92738) Avail: CASI HC A06/MF A02

Two formulations for the analogy defect of binary systems are presented in which the dependence of the Schmidt number is empirically introduced in the principles of film theory and frictionless flow. The plate-parallel convection with a linearly increasing flow profile was taken into account. The mass transfer was considered independently of the heat transfer. The flow was described by the continuity and Navier-Stokes equations and the diffusion effects were expressed by the Fick law through the mass concentration gradients. The mass transfer was calculated from binary, equimolar systems and for ternary systems such as methanol-helium, water-helium, acetone-benzole-helium and isopropanol-water-nitrogen. A method for the estimation of reference values of mass density and dynamic viscosity mixtures with components whose molar masses are significantly different is presented. ESA

**N93-18721#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

**AXIAL FLOW COMPRESSORS, VOLUME 1**

1992 435 p Lecture series held in Rhode-Saint-Genese, Belgium, 27-31 Jan. 1992
(VKI-LS-1992-02-Vol-1; ETN-92-92164) Avail: CASI HC A19/MF A04

Lectures mainly concentrating on the rotating stall aspect of the unsteady flow, and to a lesser extent on the new features in the blade design, are presented. Fundamental flow behavior and detailed structures of the stall pattern were discussed, using laboratory experiments. The full scale problems were addressed in the lectures on the experiments and analytical studies made on engine compressors. The flow imposed upon a compressor by the inlet was described in an introductory lecture to situate the problem. The description and inception of stall, with ideas about active control, started the lectures on stall related problems. It is expected that compressors can be operated closer to the stall line by monitoring the signs of an imminent stall and taking appropriate action. Laboratory models were discussed using single and multistage configurations, with a comparison to engine type compressor behavior. For individual titles, see N93-18722 through N93-18730.

**N93-18722#** Rolls-Royce Ltd., Derby (England). Compressor Engineering Dept.

**THE EFFECT OF AIRCRAFT INLETS ON THE BEHAVIOUR OF AERO ENGINE AXIAL FLOW COMPRESSORS**

Christopher J. Freeman *In* VKI, Axial Flow Compressors, Volume 1 1992 31 p (For primary document see N93-18721 06-34)
Avail: CASI HC A03/MF A04

The air inlet and its effect on turbocompressors are described, covering the following: the engine aircraft operating envelopes, inlet loading, interaction between inlet and compressor, compression distortion tolerance, response of compressor to inlet total pressure distortion, inlet and outlet static pressure distribution, and other threats to compressor stability due to inlet. The following conclusions are made: the aircraft operating envelope is demanding of the inlet when the pressures to reduce size cost, weight, and drag are obvious; the inlet separates at the edges of the envelope; the separation can be reduced by applying well known scaling laws; this asymmetric separation can degrade the compressor surge margin; and the stability margin of the engine can be affected by other features of the inlet. ESA

**N93-18723#** Rolls-Royce Ltd., Derby (England). Compressor Engineering Dept.

**STALL IN AXIAL FLOW AERO ENGINE COMPRESSORS**

Christopher J. Freeman *In* VKI, Axial Flow Compressors, Volume 1 1992 30 p (For primary document see N93-18721 06-34)
Avail: CASI HC A03/MF A04

The inception of stall in an aeroengine compressor over a range of speeds and the post stall behavior are described. Reference is made to the varying matching and system response as the speed is increased and the effects demonstrated on a single shaft gas turbine. In particular, the following are detailed: surge and stall in axial compressors, compressor matching, low speed stalls, mid speed stalls, stalls ending in rotating stalls, high speed surges, contour plots of stage 1, 4, and 7 pressures, and compressor behavior during surge. ESA

**N93-18724#** Cambridge Univ. (England). Whittle Lab.

**STALL AND SURGE IN AXIAL FLOW COMPRESSORS**

Ivor J. Day *In* VKI, Axial Flow Compressors, Volume 1 1992 35 p (For primary document see N93-18721 06-34)
Avail: CASI HC A03/MF A04

Detrimental effects of rotating stall and surge on compressor performance is discussed. Stall and surge in axial flow compressors is introduced from first principles and in an experimental nature. The following are described: fully developed rotating stall, fully developed surge, stall inception, surge inception, and the dividing line between stall and surge. ESA

**N93-18725#** Cambridge Univ. (England). Whittle Lab.

**ACTIVE CONTROL OF STALL AND SURGE**

Ivor J. Day *In* VKI, Axial Flow Compressors, Volume 1 1992 39 p (For primary document see N93-18721 06-34)
Avail: CASI HC A03/MF A04

The use of active control to avoid the detrimental effects of rotating stall and surge on compressor performance is discussed. The following are detailed: the active control of surge on centrifugal compressors; the active control of stall in axial compressors, covering supressions of both long length and short length scale disturbances; and the active control of surge in an axial compressor. ESA

**N93-18726#** Cornell Univ., Ithaca, NY. Sibley School of Mechanical and Aeronautical Engineering.

**STALL TRANSIENTS INCLUDING EFFECTS OF INLET DISTORTION AND INTAKE GEOMETRY**

F. K. Moore *In* VKI, Axial Flow Compressors, Volume 1 1992 80 p (For primary document see N93-18721 06-34)
Avail: CASI HC A05/MF A04

Combined cycle theory and its enabling approximations (differential equations for stall transients) are reviewed. Developments to the theory are described: amendment to include inlet flow distortion and estimation of steady stall margin. Advances in improving the physical models used in the theory, especially those pertaining to the inlet flow, compressibility, and the axisymmetric characteristic are discussed. Computational efforts to properly treat the shape of circumferential waves and to correctly analyze potential flow in an ideal inlet are addressed. The relation of the transient theory to modern nonlinear mechanics is noted in bifurcation analysis. ESA

**N93-18727#** Cranfield Inst. of Tech., Bedford (England).
**EXPERIMENTAL INVESTIGATION OF ROTATING STALL IN A MISMATCHED THREE STAGE AXIAL FLOW COMPRESSOR**
G. L. Giannissis, A. B. McKenzie, and R. L. Elder *In* VKI, Axial Flow Compressors, Volume 1 1992 19 p (For primary document see N93-18721 06-34)
Avail: CASI HC A03/MF A04

An examination of rotating stall in a low speed three stage axial flow compressor operating with various degrees of stage mismatch is reported. The objective was to simulate the mismatching which occurs in high speed multistage compressors when operating near surge. The study of the stall zones involved the use of fast response measurement techniques. The study clearly shows how stages can operate in an axisymmetric fashion even when heavily stalled, rotating stall inception requiring the stall of more than one stage. Conditions required for full span and part span stall are compared and the part span stall structure is suggested to be the more relevant to high speed multistage compressors. ESA

**N93-18728#** Cranfield Inst. of Tech., Bedford (England).
**APPLICATION OF RECESS VANED CASING TREATMENT TO AXIAL FLOW FANS**
A. R. Azimian, R. L. Elder, and A. B. McKenzie *In* VKI, Axial Flow Compressors, Volume 1 1992 25 p (For primary document see N93-18721 06-34)
Avail: CASI HC A03/MF A04

The effect of applying a vaned recessed casing treatment to a single stage axial flow fan was investigated. The influence of the axial position of the recess relative to the rotor leading edge and other geometrical modifications of the vane passage were examined. Significant improvements in stall margin were observed without (in some builds) loss in peak efficiency. Slow and fast frequency response yawmeter probes were used to examine both the steady flow conditions and the unsteady flow caused by rotating stall. ESA

**N93-18729#** Cranfield Inst. of Tech., Bedford (England).
**A STUDY OF STALL IN A LOW HUB/TIP RATIO FAN**
M. Soudranayagam and R. L. Elder *In* VKI, Axial Flow Compressors, Volume 1 1992 30 p (For primary document see N93-18721 06-34)
Avail: CASI HC A03/MF A04

An investigation to define the process of rotating stall inception in a low speed, low hub/tip ratio fan is presented. Based on elementary cascade analysis, the fan would be expected to stall from the root, however, considerable experimental evidence indicates that tip stall is more frequently incurred. A study of streamtube contraction indicates that the root rematches to a more stable operating point, thus, alleviating some of the problems in that region. The experimental investigation was undertaken on an isolated rotor with successive build modifications to increase the likelihood of rotating stall inception at the root. It was apparent that real fluid effects tended to steepen the root pressure rise characteristic, thus, enhancing the stability in that region. The performance of the fan at the tip tended to be poor providing a pressure characteristic with a lower negative gradient than anticipated indicating less stability than simple flow models would suggest. Hot wire flow mapping at the rotor exit supported the overall conclusion that the rotor showed a strong reluctance to stall at the root apparently due to 'centrifuging' of the boundary layer towards the tip. ESA

**N93-18730#** Rolls-Royce Ltd., Derby (England). Compressor Engineering Dept.
**ENDWALL FLOWS AND BLADING DESIGN FOR AXIAL FLOW COMPRESSORS**
Christopher J. Robinson *In* VKI, Axial Flow Compressors, Volume 1 1992 136 p Sponsored in part by Department of Trade and Industry (For primary document see N93-18721 06-34)
Avail: CASI HC A07/MF A04

Literature relevant to blading design in the endwall region is reviewed, and important three dimensional flow phenomena occurring in embedded stages of axial compressors are described. A low speed axial flow four stage compressor rig is described and bladings studied are detailed: two conventional and two with end bends. The application of a three dimensional Navier-Stokes solver to the bladings' stators, to assess the effectiveness of the code, is reported. Calculation results of exit whirl angles, losses, and surface static pressures are compared with experiment. ESA

**N93-18731#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**AXIAL FLOW COMPRESSORS, VOLUME 2**
1992 332 p Lecture series held in Rhode-Saint-Genese, Belgium, 27-31 Jan. 1992
(VKI-LS-1992-02-Vol-2; ETN-92-92165) Avail: CASI HC A15/MF A03

Lectures on the following are presented: modeling and measurement techniques for rotating stall in unsteady loss/flowfield; the determination of the zone of the stall cell by means of baroclinic wave theory; rotating stall cell and von Karman vortex street; and the performance of controlled diffusion blades. For individual titles, see N93-18732 through N93-18735.

**N93-18732#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**ROTATING STALL: MODELING-MEASUREMENT TECHNIQUES; UNSTEADY LOSS-UNSTEADY FLOW FIELD**
Frans A. E. Breugelmans and P. Lippert *In its* Axial Flow Compressors, Volume 2 1992 205 p (For primary document see N93-18731 06-34)
Avail: CASI HC A10/MF A03

A study to find a method which predicts, based on the single stage characteristics of a multistage compressor, the position of the rotating stall line, is presented. Restricted to the big stall phenomenon, the mass flow rate of the stalled compressor and the delivered pressure rise were to be determined. A literature survey shows that rotating stall is extensively investigated. In spite of the large amount of studies, the physical reasons of the phenomenon are still unknown. A review of the different approaches is given. To determine the pressure rise and the stage loading during stall in a multistage compressor, a numerical analysis was carried out. A model based on experimental results taken in the rotating stall region in a single and multistage compressor is described. The model of the stalled flow was calibrated with inhouse data and applied to compressor builds taken from literature. A good agreement between the measured flow coefficient and pressure rise and the predicted values was obtained. ESA

**N93-18733#** Technische Univ., Hanover (Germany).
**DETERMINATION OF THE ZONE OF THE STALL CELL BY MEANS OF THE BAROCLINIC WAVE THEORY**
Y. N. Chen, U. Haupt, U. Seidel, and M. Rautenberg *In* VKI, Axial Flow Compressors, Volume 2 1992 11 p Sponsored by DFG (For primary document see N93-18731 06-34)
Avail: CASI HC A03/MF A03

For axial compressor flow, the determination of the stall cell as the area enclosed by the baroclinic waves of the inlet and outlet is shown. Axial and tangential velocities are shown. The determination of the meridional recirculation and of the tangential recirculations around the stall cell bubble are shown. ESA

**N93-18734#** Technische Univ., Hanover (Germany). Inst. of Turbomachinery.
**ROTATING STALL CELL AND VON KARMAN VORTEX STREET: A METEOROLOGICAL THEORY**
Y. N. Chen (Sulzer Bros. Ltd., Winterthur, Switzerland ), U. Haupt, U. Seidel, and M. Rautenberg *In* VKI, Axial Flow Compressors, Volume 2

1992 73 p (For primary document see N93-18731 06-34)
Avail: CASI HC A04/MF A03

A meteorological theory is established for the rotating stall in axial turbocompressors. This is guided by the Rossby wave of the blade channels under the action of the baroclinic waves in the annular spaces in front of and behind the rotor and the circular Karman vortex street around the circumference of the rotor. The following are described: derivation of the established stall cell as a bubble guided by a Karman vortex pair; the reverse flow as the initiating factor for the inception of rotating stall; baroclinic wave and thermal wind; and inception of the rotating stall by intensified reverse flow. ESA

**N93-18735#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany).
**PERFORMANCE OF CONTROLLED DIFFUSION BLADES**
Hans Starken *In* VKI, Axial Flow Compressors, Volume 2 1992 47 p (For primary document see N93-18731 06-34)
Avail: CASI HC A03/MF A03

The development of blade design methods for axial flow compressors is addressed. The introduction gives a review of the techniques developed over recent years. Subsonic and supercritical pressure distributions are discussed. Criteria for the supercritical compressor blade suction surface pressure distribution design are given. ESA

**N93-18769*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**IMPLEMENTATION OF A PARALLEL UNSTRUCTURED EULER SOLVER ON SHARED AND DISTRIBUTED MEMORY ARCHITECTURES Final Report**
D. J. Mavriplis, Raja Das, Joel Saltz, and R. E. Vermeland (Cray Research, Inc., Eagan, MN.) Washington Dec. 1992 21 p Submitted for publication
(Contracts NAS1-18605; NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-189742; NAS 1.26:189742; ICASE-92-68) Avail: CASI HC A03/MF A01

An efficient three dimensional unstructured Euler solver is parallelized on a Cray Y-MP C90 shared memory computer and on an Intel Touchstone Delta distributed memory computer. This paper relates the experiences gained and describes the software tools and hardware used in this study. Performance comparisons between two differing architectures are made. Author

**N93-18884*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**A KINETIC THEORY TREATMENT OF HEAT TRANSFER IN PLANE POISEUILLE FLOW WITH UNIFORM PRESSURE**
Parviz A. Bahrami Dec. 1992 19 p
(RTOP 505-59-40)
(NASA-TM-103993; A-93021; NAS 1.15:103993) Avail: CASI HC A03/MF A01

Plane compressible Poiseuille flow with uniform pressure (Couette flow with stationary boundaries) is revisited where the Lees two-steam method with the Enskog equation of change is applied. Single particle velocity distribution functions are chosen, which preserve the essential physical features of this flow with arbitrary but uniform plate temperatures and gas pressure. Lower moments are shown to lead to expressions for the parameter functions, molecular number densities, and temperatures which are entirely in agreement with those obtained in the analysis of Lees for compressible plane Couette flow in the limit of low Mach number and vanishing mean gas velocity. Important simplifications result, which are helpful in gaining insight into the power of kinetic theory in fluid mechanics. The temperature distribution, heat flux, as well as density, are completely determined for the whole range of Knudson numbers from free molecular flow to the continuum regime, when the pressure level is specified. Author

**N93-18885*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**COHERENT STRUCTURES IN A SIMULATED TURBULENT MIXING LAYER**
Robert D. Moser and Michael M. Rogers Oct. 1992 15 p
(RTOP 505-59-53)
(NASA-TM-103980; A-92197; NAS 1.15:103980) Avail: CASI HC A03/MF A01

A direct numerical simulation of a plane turbulent mixing layer has been performed. The simulation was initialized using two turbulent velocity fields obtained from direct numerical simulation of a turbulent boundary layer at momentum thickness Reynolds number 300 (Spalart, 1988). The mixing layer is allowed to evolve long enough for self-similar linear growth to occur, with the visual thickness Reynolds number reaching 14,000. The simulated flow is examined for evidence of the coherent structures expected in a mixing layer (rollers and rib vortices). Before the onset of self-similar growth, such structures are present with properties similar to the corresponding laminar or transitional structures. In the self-similar growth regime, however, only the rollers are present with no indication of rib vortices and no indication of conventional pairing. This results in a reduction of mixing and layer growth. Author

**N93-18990#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**SHOCK TUBE STUDY OF THE EFFECTS OF LARGE DENSITY DIFFERENCES AND BLOWING RATIO ON HEAT TRANSFER TO A FILM-COOLED FLAT PLATE Final Report**
Thomas A. Eads 30 Nov. 1992 183 p
(AD-A258813; AFIT/GAE/ENY/92D-25) Avail: CASI HC A09/MF A02

The effects of coolant-to-mainstream density ratio (D.R.) and mass flux (blowing) ratio (Mb) on flat plate heat transfer were investigated in a shock tube. The round-nosed plate has a single row of holes inclined 35 deg downstream with two-diameter lateral spacing and hole length of three diameters. Mixing helium with air in the shock tube produced a D.R. range of 1.2 to 2.1. The parameters studied approach those of film-cooled turbine components. For an Mb range of 0.4 to 3 and 10 percent mainstream turbulence, heat flux was measured with thin-film heat flux gauges located 4 to 30 hole diameters downstream of the cooling holes using an electrical analog. Various flow conditions were produced over the flat plate. The 'steady' portion of turbulent flow heat transfer data compared within 20 percent of the theoretical flat plate solution. Ratios of heat flux with cooling to heat flux without cooling versus M. and D.R. were determined. Analysis of the results showed film cooling heat transfer is correlated by coolant-to-mainstream velocity ratio. Effectiveness of cooling was reduced by the high mainstream turbulence. GRA

**N93-19009*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**DEVELOPMENT OF A FRACTIONAL-STEP METHOD FOR THE UNSTEADY INCOMPRESSIBLE NAVIER-STOKES EQUATIONS IN GENERALIZED COORDINATE SYSTEMS**
Moshe Rosenfeld (MCAT Inst., San Jose, CA.), Dochan Kwak, and Marcel Vinokur (Sterling Software, Palo Alto, CA.) Nov. 1992 60 p
(RTOP 505-10-01)
(NASA-TM-103912; A-92042; NAS 1.15:103912) Avail: CASI HC A04/MF A01

A fractional step method is developed for solving the time-dependent three-dimensional incompressible Navier-Stokes equations in generalized coordinate systems. The primitive variable formulation uses the pressure, defined at the center of the computational cell, and the volume fluxes across the faces of the cells as the dependent variables, instead of the Cartesian components of the velocity. This choice is equivalent to using the contravariant velocity components in a staggered grid multiplied by the volume of the computational cell. The governing equations are discretized by finite volumes using a staggered mesh system. The solution of the continuity equation is decoupled from the momentum equations by a fractional step method which enforces mass conservation by solving a Poisson equation. This procedure, combined with the consistent approximations of the geometric quantities, is done to satisfy the discretized mass conservation equation to machine accuracy, as well as to gain the favorable convergence properties of the Poisson solver. The momentum equations are solved by an approximate factorization method, and a novel ZEBRA scheme with four-color ordering is devised for the efficient solution of the Poisson equation. Several two- and three-dimensional laminar test cases are computed and compared with other numerical and experimental results to validate the solution method. Good agreement is obtained in all cases. Author

**N93-19011*#** Sterling Federal Systems, Inc., Palo Alto, CA.
**EFFECT OF NON-EQUILIBRIUM FLOW CHEMISTRY ON THE HEATING DISTRIBUTION OVER THE MESUR FOREBODY DURING A MARTIAN ENTRY**
Yih-Kang Chen Sep. 1992 24 p
(Contract NAS2-13210)
(NASA-CR-177601; A-92190; NAS 1.26:177601) Avail: CASI HC A03/MF A01

Effect of flow field properties on the heating distribution over a 140 deg blunt cone was determined for a Martian atmosphere using Euler, Navier-Stokes (NS), viscous shock layer (VSL), and reacting boundary layer (BLIMPK) equations. The effect of gas kinetics on the flow field and the surface heating distribution were investigated. Gas models with nine species and nine reactions were implemented into the codes. Effects of surface catalysis on the heating distribution were studied using a surface kinetics model having five reactions. Author

**N93-19013*#** Florida Inst. of Tech., Melbourne. Dept. of Mechanical and Aerospace Engineering.
**DEVELOPMENT AND VERIFICATION OF METHODS FOR PREDICTING FLOW RATES THROUGH LEAKS IN VALVES AND COUPLINGS Final Report, 15 Sep. 1991 - 31 Jan. 1993**
John M. Russell 8 Mar. 1993 21 p
(Grant NAG10-0089)
(NASA-CR-192270; NAS 1.26:192270) Avail: CASI HC A03/MF A01

This is the final report of a research effort which addresses the title problem. The report discusses two broad models of flows, which represent the following extreme cases: (1) inertia-dominated flow, where friction is relatively insignificant; and (2) friction-dominated flow where inertia is insignificant. In class (2), the leak channel might consist of the gap between a scratch in a plastic seal and a polished metal plate against which the seal is pressed. Here, the cross section of the leak channel is modeled as a flat bottomed crescent. A publication generated under the present grant period presents an exact solution of the equations of fully-developed laminar pipe flow of a liquid in the case of a crescent beneath a hyperbolic arc. A Master's thesis project supported by the present grant presents the corresponding solution beneath a circular arc. A second publication reviews the flow of a gas through the same channel, which may be analyzed by a standard one-dimensional model (Fanno flow) for an engineering approximation. Finally, the report discusses the design and progress in the fabrication of a leak-test cell, in which one may measure the flow of fluid through a controlled flaw in a seal. The aim of such measurements is to furnish data for comparison with the predictions of the theory. Author

**N93-19040** Rutgers - The State Univ., New Brunswick, NJ.
**PENETRATIVE AND RECIRCULATING FLOWS IN ENCLOSURES WITH OPENINGS Ph.D. Thesis**
Abdulkarim Hashi Abib 1992 308 p
Avail: Univ. Microfilms Order No. DA9232893

The present work was undertaken to numerically simulate the flows generated by fires in enclosures such as rooms. Numerical solutions of the initial-value problem are obtained by marching in time until steady state is reached. A control-volume finite-difference method, in stream function vorticity formulation, is employed for the solution. A modified version of the low Reynolds number k-epsilon model is used for the turbulent flow calculations. The study mainly focuses on the interaction between the open cavity and the ambient medium beyond the opening. A wide range of the Grashof number Gr, spanning both laminar and turbulent flow regimes, is considered. The effort is directed at determining the heat transfer rate, the mass flow rate, the penetration distance of the thermal plume rising above the source, the turbulence characteristics and the stratification levels generated within the cavity, in order to investigate the resulting penetrative and recirculating flow. Contour plots of the mean temperature and stream function, the velocity fluctuations and the eddy diffusivity are also shown to qualitatively describe the flow and the thermal field. In the case of a stably stratified ambient medium, it was found that, depending on the stratification parameter, the thermal plume that arises above the heat source or fire may never reach the ceiling. Small penetration distances occur at large stratification levels. The flow field reveals a multicellular pattern: a strong main convective cell at the bottom and a weak counter cell at the top. Furthermore, it is observed that the penetrative convection occurs in the form of nearly horizontal motion in the lowest part of the stable upper-layer corresponding to the top portion of the main convective cell. In an isothermal environment, however, a strong stable thermal stratification is generated within the cavity, particularly at high Grashof number Gr and small opening height. The effects of wall thermal boundary conditions are examined and it is observed that the heat transfer across the ceiling has a major influence on the turbulent flow in the room. Other important details on this penetrative transport are also brought out. Dissert. Abstr.

**N93-19041** Vanderbilt Univ., Nashville, TN.
**AN INVESTIGATION OF THE NEAR AND INDUCED FLOW FIELDS OF AN AXIALLY SYMMETRIC JET, ISSUING NORMAL TO A PLANE SURFACE, INTO A QUIESCENT MEDIUM Ph.D. Thesis**
Barry Francis Battista 1992 182 p
Avail: Univ. Microfilms Order No. DA9300046

An investigation of the near and induced flow fields associated with a turbulent, axially symmetric jet, issuing normal to a solid surface, was performed. In this case, the near-field was defined as the portion of the jet extending from the plane of the exit to a downstream location, 15 diameters away. This study was conducted using a 0.50-inch (1.27 cm) diameter, circular jet orifice, centrally located in a flat steel plate. Exit velocities within the range given by 210 less than U(sub 0) less than 325 fps (67 less than U(sub 0) less than 100 m/s) were considered. Results of this investigation showed that the presence of a solid wall, in the plane of the exit, produced marked changes in the behavior of the jet (as compared to a jet issuing from a point source) and that classical jet theory should not be expected to accurately predict the characteristics of flows associated with such geometries. It was further shown that the assumptions of constant axial momentum flux and constant interior static pressure (i.e. within the jet) are not valid for the case in point. Because these assumptions are instrumental in the development of classical jet theory, it was deduced that existing theory may not be extended to circular jets issuing normal to solid boundaries. In the absence of an applicable theory, a comprehensive body of data is provided to describe the behavior of such a jet. A special technique was developed to determine the direction of fluid motion and the angle of induced flow, using hot-wire anemometers. While surveys of the induced flow field show the outer fluid to have a component of velocity counter to the direction of bulk fluid motion within the jet, this counterflow was not observed beyond 10 diameters from the exit (i.e. the source). Furthermore, there is no evidence to suggest that the noted decrease in the near-field axial momentum of the jet is attributable, in any significant degree, to the induced flow field. Rather, the apparent logarithmic decay of the axial momentum flux is attributed to the effects of viscous dissipation and turbulence-induced mixing, particularly in the first five or six diameters downstream of the source, where the drop in axial momentum is largest. Dissert. Abstr.

**N93-19055** Connecticut Univ., Storrs.
**VORTICAL AND TURBULENT STRUCTURE OF PLANAR AND LOBED MIXER FREE-SHEAR LAYERS Ph.D. Thesis**
Duane Clark McCormick 1992 196 p
Avail: Univ. Microfilms Order No. DA9300954

A comprehensive experimental investigation of the free-shear layer vortical and turbulent structure downstream of a lobed mixer has been conducted. Pulsed-laser flow visualization with smoke and three-dimensional velocity measurements with triple-sensor hot film anemometry were obtained for two lobed mixer configurations (symmetric and unsymmetric waveforms) and a baseline, planar configuration. Both laminar and turbulent initial boundary layer conditions were documented for each of the three configurations. The main result of this investigation is that a new vortex structure was found to exist for the lobed mixers in addition to the well-known streamwise vortex array. The normal vortex (due to the Kelvin-Helmholtz instability) sheds periodically from the convoluted trailing edge of the lobed mixer and plays a major part in the enhanced mixing process in combination with the streamwise vorticity. The streamwise vorticity deforms the normal vortex into a pinched-off structure that creates intense turbulence and mixing. The scale of the normal vortex was approximately one fourth that of the planar case, thereby introducing a small-scale turbulence over a large cross-stream area of the flow that dominates the near-field Reynolds shear stress distribution. Thus, the lobed mixer free-shear layer provides enhanced mixing down to the molecular scale. The shear layer growth rate for the first 5-6 lobe heights was substantially greater than the planar free-shear layer due to the normal and streamwise vortex interaction.

Downstream of six lobe heights, the growth rate slowed considerably to a rate below that of the planar configuration due to the reduced turbulent kinetic energy of a double-layered shear layer structure. The streamwise and normal vorticity were completely dissipated by 5-6 lobe heights. Also, the lobe mixer development was found to be surprisingly insensitive to initial laminar and turbulent boundary layer conditions (unlike the planar case). Dissert. Abstr.

**N93-19056** Washington Univ., Seattle.
**STABILITY OF NONEQUILIBRIUM SHEAR FLOWS Ph.D. Thesis**
Perry Allen Meyer 1992 176 p
Avail: Univ. Microfilms Order No. DA9239473

A temporal stability analysis is performed for inviscid, real gas, plane shear flows with multiple nonequilibrium processes such as relaxation and chemical reactions. Both analytical and numerical results are presented and compared with classical equilibrium flow results. The equations governing three-dimensional disturbances are developed. Linearized rate equations are shown to be consistent with well known physical examples. The stability of a vortex sheet is analyzed and growth rates are found numerically. An instability associated with nonequilibrium is found to be present for all Mach numbers. This is explained in terms of the pressure distribution for nonequilibrium flow over a wavy wall. The equation governing the temporal stability of continuous shear layers is developed. Complex expressions due to nonequilibrium and thermodynamic state are interpreted. The frozen and equilibrium sound speeds (defined for multiple nonequilibrium mixtures) appear naturally. A gas with N nonequilibrium variables is found to have N associated modes of instability. The solution to the multiple nonequilibrium problem is found by taking the linear combination of single nonequilibrium solutions. Three-dimensional disturbances are shown to be more unstable than two-dimensional ones. The constant temperature hyperbolic-tangent free shear layer is analyzed and growth rates and phase speeds are found numerically for bounded and unbounded flows. For the unbounded case, a supersonic, stationary mode of instability is found when nonequilibrium is present. Supersonic acoustic modes are drastically diminished by nonequilibrium. For bounded flows, acoustic modes are damped when the disturbance wave length is small compared to the channel width. The effects of variable temperature are examined for vibrational nonequilibrium. The shear core is found to shift towards equilibrium and a slight stabilization occurs. Certain aspects of the stability of jets and wakes are addressed. Temporal and spatial approaches are related. Numerical results are obtained for the hyperbolic-secant velocity profile. Unlike the free shear layer, nonequilibrium is found to have no unique influences, other than to effectively shift the jet Mach number. Dissert. Abstr.

**N93-19076#** Mitre Corp., McLean, VA.
**DRAG REDUCTION BY POLYMER ADDITIVES**
P. Diamond, J. Harvey, J. Katz, D. Nelson, and P. Steinhardt Oct. 1992 57 p
(AD-A258867; JSR-89-720) Avail: CASI HC A04/MF A01

The 1989 JASON Summer Study on Drag Reduction focused on the physics which underlies methods utilizing polymer studies. The study included a review of drag reduction phenomenology, the development of continuum models of the dynamics of dilute polymer solutions, the introduction of a simple theory of poly-hydrodynamic turbulence and a discussion of its implications for grid flows, and consideration of optimizing polymer architecture. GRA

**N93-19097#** Pennsylvania State Univ., University Park. Applied Research Lab.
**ESTIMATION OF THE DIRECT ACOUSTIC RADIATION FROM TURBULENT SPOTS. USING BOUNDARY LAYER VELOCITY MEASUREMENTS**
M. H. Krane and W. R. Pauley Nov. 1992 152 p
(Contract N00014-90-J-1365)
(AD-A258981; PSU/ARL-TR-92-11) Avail: CASI HC A08/MF A02

To provide an understanding of the acoustic source characteristics of the boundary layer transition region, unsteady velocity field measurements of an isolated, artificially generated turbulent spot were made in a zero-pressure gradient laminar boundary layer. These measurements were performed in a water channel, using a laser Doppler velocimeter. They provide quantitative information describing the large scale unsteady displacement thickness fluctuations due to the passage of a turbulent spot. Fluctuations of the displacement thickness are related to the radiated noise through the Liepmann acoustic analogy. The description of the large-scale velocity field is based on ensemble-averaged unsteady velocity data, from which the displacement thickness is calculated. These results are used to calculated the velocity normal to the plate, as well as the characteristic rise times, ti, of the displacement thickness. Comparison of the results at different steamwise stations shows that the rise time and the mass flux deficit peak amplitudes of the normal velocity increase early in the spot development, but level off. For all these parameters, the rate of spatial growth is greatest in the stations closest to the generation point. GRA

**N93-19101#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**THE EFFECTS OF VISCOSITY ON A CONICALLY DERIVED WAVERIDER M.S. Thesis**
James A. Mundy Dec. 1992 58 p
(AD-A259019; AFIT/GAE/ENY/92D-23) Avail: CASI HC A04/MF A01

This study investigated the effects of the interaction between the viscous boundary layer and the shock wave produced by a Mach 10 inviscid optimized waverider. An implicit, Roe flux-splitting algorithm, developed by WL/FIMM, was used to solve the flow field. A validation for the inviscid version of the CFD algorithm was accomplished by comparing the numerical data produced by the CFD code to the analytic results derived by Rasmussen, and by comparison to results of the explicit version of the same Roe flux-splitting code. The computational results compared favorably. The inviscid case studied using the implicit code produced results identical, for all practical purposes, to those of the explicit code, though approximately twice as quickly. The results of the viscous flow case matched well with the results predicted by theory. The lift to drag ratio calculated, 5.74, is comparable to the results of other researchers. GRA

**N93-19348*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**ASSESSMENT OF NONEQUILIBRIUM RADIATION COMPUTATION METHODS FOR HYPERSONIC FLOWS**
Surendra Sharma Jan. 1993 41 p
(RTOP 506-40-00)
(NASA-TM-103994; A-93023; NAS 1.15:103994) Avail: CASI HC A03/MF A01

The present understanding of shock-layer radiation in the low density regime, as appropriate to hypersonic vehicles, is surveyed. Based on the relative importance of electron excitation and radiation transport, the hypersonic flows are divided into three groups: weakly ionized, moderately ionized, and highly ionized flows. In the light of this division, the existing laboratory and flight data are scrutinized. Finally, an assessment of the nonequilibrium radiation computation methods for the three regimes in hypersonic flows is presented. The assessment is conducted by comparing experimental data against the values predicted by the physical model. Author

**N93-19367#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**REWET PERFORMANCE OF A RECTANGULAR GROOVED HEAT PIPE WICK AFTER GRAVITATIONALLY INDUCED DRYOUT M.S. Thesis**
Lowell S. Hawthorne Dec. 1992 142 p
(AD-A258852; AFIT/GA/ENY/92D-04) Avail: CASI HC A07/MF A02

The effects of increased acceleration forces on the transient dryout and rewet performance of an axial groove heat pipe wick were experimentally studied using inclination to simulate increased acceleration forces. Two durations of increased acceleration were investigated, one being less than the time required for the groove to reach steady-state dryout conditions, the other being sufficient to ensure the groove had reached steady-state dryout conditions. The groove's extent of dryout was found to be greater at increased levels of acceleration. The period of time required for the groove to rewet after an acceleration induced dryout increased as acceleration increased. The period of time for rewet was independent of duration for higher acceleration levels. The time period required for the groove to return to starting steady-state temperatures was zero for short durations of increased acceleration, and increased as acceleration increased for short durations. GRA

**N93-19450#** New York Univ., New York. Inst. of Mathematical Sciences.
**PERTURBATION PROBLEMS IN FLUID DYNAMICS Final Report, 15 Oct. 1989 - 14 Oct. 1992**
Lu Ting 6 Nov. 1992 15 p
(Grant AF-AFOSR-0022-90)
(AD-A258934; CIMS-92-11-06; AFOSR-92-0980TR) Avail: CASI HC A03/MF A01

Perturbation methods and numerical methods were employed to study five problem areas. (1) For viscous vortical flows, a complete account of the asymptotic analyses, numerical studies and their physical meaning was presented in Springer-Verlag Lecture Notes in 1991. An extension of the asymptotic analysis for the motion and diffusion of a slender vortex filament to allow for the variation of the core structure along the filament was accomplished in 1992. This extension was needed for the study of the vortex breakdown problem. (2) For shock wave interactions, the locations and the types of singularities in the interaction of semilinear waves in three- and higher dimensional space were identified. (3) For wave propagations in a bubbly liquid, a survey of the linear and nonlinear theories and their limitations was presented in an article in Advances in Applied Mechanics in 1991. A system of effective equations uniformly valid at small gas volume fraction and large bubble number density was derived in 1992. (4) For free boundary problems, solutions simulating the breaking up or merging of symmetric slender jets or thin sheets were obtained in 1990. The solution for drop formation after the breaking was formulated recently. (5) In the analysis of structural/acoustic interactions, the solution for the panel oscillation was uncoupled from that for the acoustic field by the recent formulation of the on surface conditions taking into account the acoustic effect. GRA

**N93-19475#** Indiana Univ., Bloomington. Inst. for Scientific Computing and Applied Mathematics.
**APPROXIMATION OF ATTRACTORS AND APPLICATIONS Progress Report**
R. Temam 23 Oct. 1992 5 p
(Contract DE-FG02-92ER-25120)
(DE93-002420; DOE/ER-25120/1) Avail: CASI HC A01/MF A01

The aim of the research project is to explore what can be learned about turbulence from both the theoretical and computational viewpoints. The project will make use of the dynamical systems approach to turbulence. DOE

**N93-19479#** Sandia National Labs., Albuquerque, NM.
**X RAY DIFFRACTION STUDY OF SHOCK-MODIFIED TETRAGONAL PHASES OF SnO2 AND MnO2**
P. Newcomer, B. Morosin, and R. A. Graham 1992 7 p Presented at the Annual Denver X Ray Conference, Denver, CO, 3-7 Aug. 1992
(Contract DE-AC04-76DP-00789)
(DE93-002488; SAND-92-0914C; CONF-9208129-8) Avail: CASI HC A02/MF A01

X-ray diffraction line-profile analysis on tetragonal forms of SnO2 (cassiterite), MnO2 (pyrolusite), and previously studied TiO2 (rutile), which were subjected to high pressure shock loading, show that residual lattice strain and coherent 'crystal' size are a function of shock parameters. An interesting observation on sample of MnO2 concerns the recovery of cubic Mn2O3 (bixbyite) in the material subjected to 22 GPa, indicating a shock-induced chemical synthesis. DOE

**N93-19500#** Syracuse Univ., NY.
**NUMERICAL AND PHYSICAL MODELLING OF BUBBLY FLOW PHENOMENA**
1992 18 p
(Contract DE-FG02-90ER-14136)
(DE93-003145; DOE/ER-14136/2) Avail: CASI HC A03/MF A01

The objective of the research was to develop a sound theoretical framework for analyzing various two-phase flows. The macroscopic behavior of these flows depends on the details of the microstructure of the dispersion, and these details, in turn, depend on the nature of the flow. Given the very diverse nature of the flows and their complex dependence on the microstructure of the dispersion, it is unlikely that a single set of equations, similar to the Navier-Stokes equations for homogeneous fluids, will apply to all the different situations. Therefore, the aim was to develop general methodologies that can be used to examine specific situations and a general understanding about different kinds of macroscopic flows. DOE

**N93-19615#** Maryland Univ., College Park.
**LAGRANGIAN ANALYSIS OF CONTAMINANT DISPERSAL IN BOUNDED TURBULENT SHEAR FLOWS**
P. S. Bernard, J. M. Wallace, and J. L. Balint 1992 7 p
(Contract DE-FG05-88ER-13838)
(DE93-002794; DOE/ER-13838/5) Avail: CASI HC A02/MF A01

Laboratory experiments and direct numerical simulations (DNS) of passive scalar contaminant disperal in bounded shear flows have been carried out. Several modifications to the laboratory wind tunnel have been carried out which will make possible laser sheet flow visualization along the whole length of the 8m test section. Backward particle paths needed to perform a Lagrangian analysis of scalar transport are in the process of being computed for each of the numerical data sets previously described. A light sheet system is being implemented which is capable of visualizing a 30cm X 30cm X 5cm portion of the wall layer in order to extract quantitative information about the structure of the scalar plumes. DOE

**N93-19858*#** Minnesota Univ., Minneapolis. Dept. of Aerospace Engineering and Mechanics.
**COMPUTATIONAL TECHNIQUES FOR FLOWS WITH FINITE-RATE CONDENSATION Final Technical Report**
Graham V. Candler [1993] 6 p Meeting of the 1993 AIAA Aerospace Sciences Meeting, Reno, NV
(Grant NAG1-1330)
(NASA-CR-192093; NAS 1.26:192093) Avail: CASI HC A02/MF A01

A computational method to simulate the inviscid two-dimensional flow of a two-phase fluid was developed. This computational technique treats the gas phase and each of a prescribed number of particle sizes as separate fluids which are allowed to interact with one another. Thus, each particle-size class is allowed to move through the fluid at its own velocity at each point in the flow field. Mass, momentum, and energy are exchanged between each particle class and the gas phase. It is assumed that the particles do not collide with one another, so that there is no inter-particle exchange of momentum and energy. However, the particles are allowed to grow, and therefore, they may change from one size class to another. Appropriate rates of mass, momentum, and energy exchange between the gas and particle phases and between the different particle classes were developed. A numerical method was developed for use with this equation set. Several test cases were computed and show qualitative agreement with previous calculations. Author

**N93-19859*#** Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
**COMPUTATIONAL REACTING GAS DYNAMICS Final Technical Report, 14 Nov. 1986 - 31 Jan. 1993**
S. H. Lam 25 Jan. 1993 140 p
(Grant NAG1-726)
(NASA-CR-192089; NAS 1.26:192089) Avail: CASI HC A07/MF A02

In the study of high speed flows at high altitudes, such as that encountered by re-entry spacecrafts, the interaction of chemical reactions and other non-equilibrium processes in the flow field with the gas dynamics is crucial. Generally speaking, problems of this level of complexity must resort to numerical methods for solutions, using sophisticated computational fluid dynamics (CFD) codes. The difficulties introduced by reacting gas dynamics can be classified into three distinct headings: (1) the usually inadequate knowledge of the reaction rate coefficients in the non-equilibrium reaction system; (2) the vastly larger number of unknowns involved in the computation and the expected stiffness of the equations; and (3) the interpretation of the detailed reacting CFD numerical results. The research performed accepts the premise that reacting flows of practical interest in the future will in general be too complex or 'untractable' for traditional analytical developments. The power of modern computers must be exploited. However, instead of focusing solely on the construction of numerical solutions of full-model equations, attention is also directed to the 'derivation' of the simplified model from the given full-model. In other words, the present research aims to utilize computations to do tasks which have traditionally been done by skilled theoreticians: to reduce an originally complex full-model system into an approximate but otherwise equivalent simplified model system.

The tacit assumption is that once the appropriate simplified model is derived, the interpretation of the detailed numerical reacting CFD numerical results will become much easier. The approach of the research is called computational singular perturbation (CSP). Author

**N93-19300#** Kyoto Univ., Sakyoku (Japan). Dept. of Aeronautical Engineering.
**A NUMERICAL SIMULATION OF FLOWS AROUND A DEFORMABLE GAS BUBBLE [HENKEI WO TOMONAU KIHOU MAWARI NO NAGARE NO SUUCHI KAISEKI]**
Minoru Sugano, Ryuji Ishii, and Shigeki Morioka *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 173-176 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

**N93-19302#** National Aerospace Lab., Kakuda (Japan). Research Center.
**SIMILARITY IN LAMINAR PIPE FLOWS WITH SECONDARY FLOWS [NIJI NAGARE WO TOMANAU KANNAI SOURYUU NO SOUJI HOUSOKU]**
Hiroshi Ishigaki, Hiroshi Tamura, Hitoshi Yamada, and Munekazu Mochizuki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 185-191 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

**N93-19303#** National Aerospace Lab., Kakuda (Japan). Research Center.
**FLOW AND HEAT TRANSFER CHARACTERISTICS OF ORTHOGONALLY ROTATING CHANNEL [KORIORI RYOKU TO ENSHIN FURYOKU GA SAYOU SURU KAITEN RYUURO NO RYUUDOU DENNETSU TOKUSEI]**
Hiroshi Tamura and Hiroshi Ishigaki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 193-196 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

**N93-19304#** National Aerospace Lab., Kakuda (Japan). Research Center.
**NUMERICAL TREATMENT OF LAMINAR FLOW IN CURVED RECTANGULAR CHANNELS WITH INLET AND OUTLET STRAIGHT REGION [SEIHOUKEI BENDO NAI NAGARE NO SUUCHI KAISEKI]**
Hitoshi Yamada, Hiroshi Ishigaki, and Munekazu Mochizuki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 197-203 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

**N93-19305#** National Aerospace Lab., Kakuda (Japan). Research Center.
**NUMERICAL ANALYSIS OF FLOW IN A HEATED HORIZONTAL SQUARE DUCT [KANETSU SARETA SUIHEIKAN NAI NAGARE NO SUUCHI KAISEKI]**
Munekazu Mochizuki and Hiroshi Ishigaki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 205-209 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

**N93-19306#** National Aerospace Lab., Kakuda (Japan).
**TURBULENCE MODEL CALCULATIONS OF THE EFFECTS OF BODY FORCES ON TURBULENT FLOWS IN A PIPE [NIJI NAGARE WO TOMONAU KANNAI RANRYUU NO KEISAN]**
Hiroshi Ishigaki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 211-215 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

**N93-19307#** National Aerospace Lab., Kakuda (Japan). Research Center.
**COMPARATIVE STUDY OF VARIOUS DIFFERENCE SCHEMES FOR SOME LAMINAR CHANNEL FLOWS [KANNAIRYUU NO KEISAN NI OKERU SABUN SUKIMU NO HIKAKU]**
Hiroshi Tamura and Hiroshi Ishigaki *In its* Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 217-220 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A01/MF A03

**N93-19319#** Tokyo Univ. (Japan).
**THREE-DIMENSIONAL MEASUREMENT OF TURBULENT SHEAR FLOWS USING DIGITAL IMAGE PROCESSING [DEJITARU GAZOU SHORI NI YORU SENDAN RANYUU NO SANJIGEN KEISOKU]**
Nobuhide Kasagi and Koichi Nishino (Yokohama National Univ., Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 289-295 In JAPANESE Sponsored by Ministry of Education and Mitsubishi Foundation (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

**N93-19407*#** North Carolina Univ., Charlotte. Dept. of Engineering Technology.
**STUDY AND DEVELOPMENT OF AN AIR CONDITIONING SYSTEM OPERATING ON A MAGNETIC HEAT PUMP CYCLE (DESIGN AND TESTING OF FLOW DIRECTORS)**
Pao-Lien Wang *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 483-500 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

**N93-19455*#** North Carolina Agricultural and Technical State Univ., Greensboro. Computational Fluid Dynamics Group.
**COMPUTATIONAL FLUID DYNAMICS RESEARCH**
Suresh Chandra, Kenneth Jones, Hassan Hassan, and David Scott McRae *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 7 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

## 35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Aircraft Instrumentation*, and *19 Spacecraft Instrumentation*.

**N93-17810#** Rome Univ. (Italy). Dipt. di Fisica.
**A HODOSCOPE MADE OF RESISTIVE PLATE CHAMBERS TO IDENTIFY MUONS IN A FIXED TARGET BEAUTY HADROPRODUCTION EXPERIMENT**
C. Bacci (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), F. Ceradini (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), G. Ciapetti (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), A. Frenkel (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), E. Gennari (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), F. Lacava (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), G. Martellotti, A. Nisati (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), D. Orestano, and G. Penso et al 30 Mar. 1992 24 p Submitted for publication
(Nota-Interna-994; ETN-93-93358) Avail: CASI HC A03/MF A01

The building of a large area hodoscope to identify muons from semileptonic decays of beauty particles produced in the WA92 experiment at the CERN Super-Proto-Synchrotron is reported. The hodoscope is made of resistive electrode chambers read out with strips of 3 cm pitch. The hodoscope has a fast response with a time resolution of 5 ns and a space resolution of 1 cm. A fast trigger processor selects straight tracks pointing to the interaction vertex in a fixed processing time of 90 ns.

ESA

**N93-17948#** Ecole Nationale Superieure des Telecommunications, Paris (France). Groupe Image.

**POSITIONING A CAMERA FROM A PHOTOGRAPH AND A SCENE MODEL**

Evelyne Lutton and Henri Maitre Jan. 1992 73 p

(TELECOM-Paris-92-D-002; ETN-93-93361) Avail: CASI HC A04/MF A01

The aim was to propose a system to compute the position and the orientation of a camera, from only one photograph, when a model of the scene is known. After having proposed a scene and a storage model (on a relational data base), according to the primitives which were reliably extracted from the images (segments of lines), the global two-dimensional to three-dimensional matching step was studied. This step consists of guiding and limiting the combinatorial search of correspondences between the image and scene segments. The developed method is based upon a geometrical treatment, which using a priori correspondences between segments, gives a first estimation of the position and orientation of the camera. This treatment and the restrictions it imposes on a global algorithm are described. These restrictions lead to the development of an original method, based upon the extraction of vanishing points on the image, in order to estimate the rotation between the image and scene coordinates, and the sets of image segments attached to each vanishing point. These two results reduce the complexity of the matching problem and enabled the feasibility of an entirely automatic method to be concluded. ESA

**N93-18034*#** Texas Univ., El Paso. Dept. of Metallurgy and Materials Engineering.

**INSTRUCTION MANUAL FOR UTEP WELD GAS HYDROGEN DETECTOR**

John McClure and Tonghui Pang 4 Aug. 1992 54 p Original contains color illustrations

(Contract NAS8-38662)

(NASA-CR-184477; NAS 1.26:184477) Avail: CASI HC A04/MF A01; 1 functional color page

The instrument described in this manual was developed at the University of Texas at El Paso under contract from the National Aeronautics and Space Administration Marshall Space Flight Center. The instrument has been used to detect hydrogen in the shielding gas of Variable Polarity Plasma Arc (VPPA) welds at concentrations of less than 100 ppm. The instrument makes measurements in real time during the welding operation and provides the operator with an easily readable graphic display of the present level of hydrogen in the arc as well as the level of hydrogen over the past approximately five minutes. In this way the welder can not only tell if the present level of hydrogen is excessive, but can see what changes in weld parameters have done to the level of hydrogen. The welder can set the level of hydrogen that is considered critical and the instrument display will indicate when that level has been exceeded. All detection is from the torch side. All needed equipment is supplied by the developer except for an IBM PC compatible computer which must be supplied by the user. Source code is supplied in this manual so that the user can modify the control program as desired. Author

**N93-18399*#** Polatomic, Inc., Richardson, TX.

**ADVANCED HELIUM MAGNETOMETER FOR SPACE APPLICATIONS Final Report**

Robert E. Slocum 1987 160 p

(Contract NAS7-993; SBIR-08.10-2753)

(NASA-CR-190880; NAS 1.26:190880) Avail: CASI HC A08/MF A02

The goal of this effort was demonstration of the concepts for an advanced helium magnetometer which meets the demands of future NASA earth orbiting, interplanetary, solar, and interstellar missions. The technical effort focused on optical pumping of helium with tunable solid state lasers. We were able to demonstrate the concept of a laser pumped helium magnetometer with improved accuracy, low power, and sensitivity of the order of 1 pT. A number of technical approaches were investigated for building a solid state laser tunable to the helium absorption line at 1083 nm. The laser selected was an Nd-doped LNA crystal pumped by a diode laser. Two laboratory versions of the lanthanum neodymium hexa-aluminate (LNA) laser were fabricated and used to conduct optical pumping experiments in helium and demonstrate laser pumped magnetometer concepts for both the low field vector mode and the scalar mode of operation. A digital resonance spectrometer was designed and built in order to evaluate the helium resonance signals and observe scalar magnetometer operation. The results indicate that the laser pumped sensor in the VHM mode is 45 times more sensitive than a lamp pumped sensor for identical system noise levels. A study was made of typical laser pumped resonance signals in the conventional magnetic resonance mode. The laser pumped sensor was operated as a scalar magnetometer, and it is concluded that magnetometers with 1 pT sensitivity can be achieved with the use of laser pumping and stable laser pump sources. Author

**N93-18428*#** Lovelace Scientific Resources, Inc., Albuquerque, NM.

**IN-SUIT DOPPLER TECHNOLOGY ASSESSMENT Final Report**

Arthur E. Schulze, Ernest R. Greene, and John J. Nadeau 31 Dec. 1991 151 p Presented at the Annual Fall Meeting of the Biomedical Engineering Society, 1992 Prepared in cooperation with General Electric Co., Houston, TX

(Contract NAS9-17884)

(NASA-CR-185692; NAS 1.26:185692) Avail: CASI HC A08/MF A02

The objective of this program was to perform a technology assessment survey of non-invasive air embolism detection utilizing Doppler ultrasound methodologies. The primary application of this technology will be a continuous monitor for astronauts while performing extravehicular activities (EVA's). The technology assessment was to include: (1) development of a full understanding of all relevant background research; and (2) a survey of the medical ultrasound marketplace for expertise, information, and technical capability relevant to this development. Upon completion of the assessment, LSR was to provide an overview of technological approaches and R&D/manufacturing organizations. Author

**N93-18595#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.

**ESTIMATION OF DISPLACEMENTS FROM TWO 3D FRAMES OBTAINED FROM STEREO [ESTIMATION DES DEPLACEMENTS A PARTIR DE DEUX SCENES 3D RECONSTRUITES PAR UN SYSTEME STEREOSCOPIQUE]**

Zhengyou Zhang and Olivier D. Faugeras Jun. 1991 47 p Sponsored in part by Commission of the European Communities

(INRIA-RR-1440; ETN-93-92647) Avail: CASI HC A03/MF A01

A method for estimating 3D (three-dimensional) displacements from two stereo frames based on the hypothesize and verify paradigm which is used to match 3D line segments between the two frames is presented. In order to produce the complexity of the method, objects are assumed to be rigid. A set of complete rigidity constraints for 3D line segments is formulated and the uncertainty of measurements are integrated into this formulation. The hypothesize and verify stages of the method use an extended Kalman filter to produce estimates of the displacements and of their uncertainty. In the experimental sections, the algorithm is shown to work on indoor and natural scenes. An extension to the case where several mobile objects are present is shown. The method is quite robust, fast, and was thoroughly tested in hundreds of real stereo frames. ESA

**N93-18647#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.

**ON THE INFORMATION CONTAINED IN THE MOTION FIELD OF LINES AND THE COOPERATION BETWEEN MOTION AND STEREO [L'INFORMATION CONTENUE DANS LE CHAMP DE VITESSES DES DROITES ET LA COOPERATION STEREO-MOUVEMENT]**

Olivier D. Faugeras, Nassir Navab, and Rachid Deriche Jun. 1991 32 p Sponsored in part by Commission of the European Communities

(INRIA-RR-1453; ETN-93-92650) Avail: CASI HC A03/MF A01

The relationships that exist between the three dimensional (3D) structure and kinematics of a line moving rigidly in space and the two dimensional structure and kinematics (motion field) of its image in one or two cameras are investigated. The fundamental equations that relate its three dimensional motion to its observed image motion are established. The estimation of this motion field from a line based token tracker is shown. Stereo matches are then assumed to have been established between image segments and the use of the estimation of the motion field in the two images to compute part of the kinematic screw of the corresponding 3D is shown. The equations are linear and if several lines belong to the same object provide a very simple way to estimate the full kinematic screw of that object. The

constrainment of the stereo matches by the motion field, by establishing necessary conditions that must be satisfied by the motion field of segments which are images of lines belonging to the same object, is shown. The idea is based upon the notion of invariance. The part of this theory which has been implemented uses Kalman filtering. Several experimental results using synthetic and real data are presented. ESA

**N93-18960#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**OPTICAL HAAR WAVELET TRANSFORMS USING COMPUTER GENERATED HOLOGRAPHY M.S. Thesis**

Peter G. Block 17 Dec. 1992 77 p

(AD-A259079; AFIT/GEO/ENG/92D-02) Avail: CASI HC A05/MF A01

This research introduces an optical implementation of the continuous wavelet transform to filter images. The wavelet transform is modeled as a correlation process and is implemented with a Vander Lugt correlator. The orthonormal basis set used is composed of two one-dimensional Haar functions and a two-dimensional Haar function. Each wavelet, as well as its first two dyadic scalings, is implemented with computer generated holography. The Interferogram method, which represents a function only in terms of its phase, is used to encode the wavelet functions. The results are imaged onto a CCD array and captured using a framegrabber. The optical results are compared to digital simulation. The results show that an optical implementation of the continuous wavelet transform was performed and that the results compared favorably to digital simulation. GRA

**N93-19328*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**FLOW RATE LOGGING SEEPAGE METER Patent Application**

William G. Reay, inventor (to NASA) (Virginia Polytechnic Inst. and State Univ., Blacksburg.) and Harry G. Walthall, inventor (to NASA) 7 Dec. 1992 16 p

(NASA-Case-LAR-14835-1; NAS 1.71:LAR-14835-1; US-Patent-Appl-SN-988077) Avail: CASI HC A03/MF A01

An apparatus for remotely measuring and logging the flow rate of groundwater seepage into surface water bodies is described. As groundwater seeps into a cavity created by a bottomless housing, it displaces water through an inlet and into a waterproof sealed upper compartment, at which point, the water is collected by a collection bag, which is contained in a bag chamber. A magnet on the collection bag approaches a proximity switch as the collection bag fills, and eventually enables the proximity switch to activate a control circuit. The control circuit then rotates a three-way valve from the collection path to a discharge path, enables a data logger to record the time, and enables a pump, which discharges the water from the collection bag, through the three-way valve and pump, and into the sea. As the collection bag empties, the magnet leaves the proximity of the proximity switch, and the control circuit turns off the pump, resets the valve to provide a collection path, and restarts the collection cycle.

NASA

**N93-19365#** Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

**THE 1991 LLWAS ANEMOMETER TEST PROGRAM Final Report, Nov. 1990 - Sep. 1991**

Charles O. Phillips, David Burnham, Leo Jacobs, and David Hazen Sep. 1992 127 p

(AD-A258844; DOT-VNTSC-FAA-92-6; DOT/FAA-W/92-1) Avail: CASI HC A07/MF A02

Performance tests of anemometers under icing and snow conditions were conducted during 1990-1991 on the test field at Rochester, MN and in icing chambers and wind tunnels at Sterling, VA. These tests were done for the FAA Low Level Windshear Alert System (LLWAS) program to test sensors for the next phase of LLWAS. Sensors from ten manufacturers were accepted into the test program from the respondents to the Commerce Business Daily. These sensors were required first to pass an icing chamber test in order to be field tested. The field tests lasted from Nov. 1990 to Jul. 1991. Afterwards, all sensors were sent to Sterling, VA for wind tunnel tests in September 1991. All units from the eight manufacturers that passed the icing chamber test were in the field test. A propeller/vane sensor that failed the icing chamber test was put in the field as a reference. All the units that passed were not affected by icing during the field test although a mechanical unit was affected by snow during one event. The propeller/vane was affected by icing during one event. Wind tunnel tests were done to check starting thresholds and calibration anomalies found in the field. It was concluded that there is no one winning technology that could be found from the tests. GRA

**N93-19371#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**IMAGE STABILIZATION PERFORMANCE OPTIMIZATION USING AN OPTICAL REFERENCE GYROSCOPE M.S. Thesis**

Jefferey T. Hammann May 1992 81 p

(AD-A258863; AFIT/CI/CIA-92-094) Avail: CASI HC A05/MF A01

An optical reference gyroscope (ORG) provides an inertially stabilized collimated optical reference beam, which, in conjunction with a fast steering mirror (FSM), allows for closed-loop control image stabilization. Feedback control permits attenuation in the image space of base motion disturbances which would tend to distort and shift the image at the focal plane. Transfer function derivations for the components and system yield the detector and image error equations. A numerical parametric study of the compensator design seeks to minimize the image error, taking into account ORG noise, base motion power spectra and ORG base-to-rotor coupling effects. A Fourier spectrum analysis of the remaining image error helps to predict the contributions to scene shift and distortion at the focal plane and the resulting image quality degradation at the charged-coupled-device imager. Analytical results are compared with test results. GRA

**N93-19387*** National Aeronautics and Space Administration. Pasadena Office, CA.

**LONG WAVELENGTH INFRARED DETECTOR Patent**

Richard P. Vasquez, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 9 Feb. 1993 6 p Filed 25 Sep. 1990 Continuation-in-part of abandoned US-Patent-Appl-SN-283443, filed 12 Dec. 1988

(NASA-Case-NPO-17543-2-CU; US-Patent-5,185,647; US-Patent-Appl-SN-562176; US-Patent-Appl-SN-283443; US-Patent-Class-257-17; US-Patent-Class-257-21; US-Patent-Class-257-23; Int-Patent-Class-H01L-27/12; Int-Patent-Class-H01L-29/161; Int-Patent-Class-H01L-27/14) Avail: US Patent and Trademark Office

Long wavelength infrared detection is achieved by a detector made with layers of quantum well material bounded on each side by barrier material to form paired quantum wells, each quantum well having a single energy level. The width and depth of the paired quantum wells, and the spacing therebetween, are selected to split the single energy level with an upper energy level near the top of the energy wells. The spacing is selected for splitting the single energy level into two energy levels with a difference between levels sufficiently small for detection of infrared radiation of a desired wavelength.

Official Gazette of the U.S. Patent and Trademark Office

**N93-19487#** California Univ., Berkeley. Lawrence Berkeley Lab.

**DESIGN OF HIGH-T(SUB c) SUPERCONDUCTING BOLOMETERS FOR A FAR INFRARED IMAGING ARRAY**

S. Verghese, P. L. Richards, D. K. Fork (Xerox Palo Alto Research Center, CA.), K. Char (Conductus, Inc., Sunnyvale, CA.), and T. H. Geballe (Stanford Univ., CA.) Aug. 1992 7 p Presented at the Applied Superconductivity Conference, Chicago, IL, 23-28 Aug. 1992

(Contract DE-AC03-76SF-00098)

(DE93-002564; LBL-32150; CONF-920802-33) Avail: CASI HC A02/MF A01

The design of high-T(sub c) superconducting bolometers for use in a far infrared imaging array from wavelengths of 30-100 microns is discussed. Measurements of the voltage noise in thin films of YBa2Cu3O(7-sigma) on yttria-stabilized zirconia buffer layers on silicon substrates are used to make performance estimates. Useful opportunities exist for imaging and spectroscopy with bolometer arrays made on micro-machined silicon membranes. A circuit on each pixel which performs some signal integration can improve the sensitivity of large two-dimensional arrays of bolometers which use multiplexed readout amplifiers. DOE

**N93-19492*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**DISCRETE OPTICAL FIBER STRAIN SENSOR Patent Application**

Claudio Oliveira Egalon, inventor (to NASA) (Analytical Services and Materials, Inc., Hampton, VA.) and Robert S. Rogowski, inventor (to

NASA) 21 Dec. 1992 15 p
(NASA-Case-LAR-14810-1-SB; NAS 1.71:LAR-14810-1-SB;
US-Patent-Appl-SN-999696) Avail: CASI HC A03/MF A01

A strain sensor uses an optical fiber including a strain sensitive portion and at least one strain insensitive portion. The strain sensitive portion is mounted on the surface of a structure at a location where a strain is desired to be measured. The strain insensitive portion(s) may be fused to the strain sensitive portion to transmit light therethrough, so that the resulting pattern may be detected to determine the amount of strain by comparison with a similar fiber not subjected to strain, or with the light pattern produced when the fiber is not under strain. NASA

**N93-19493*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**MULTIPLE LAYER DIELECTRICS, HOT FILM SENSORS, AND METHODS OF PRODUCING SAME Patent Application**
Sang Q. Tran, inventor (to NASA), Benjamin M. Copeland, Jr., inventor (to NASA), and Michael T. Oliver, inventor (to NASA) 31 Aug. 1992 13 p
(NASA-Case-LAR-14591-1; NAS 1.71:LAR-14591-1;
US-Patent-Appl-SN-957014) Avail: CASI HC A03/MF A01

The invention is a method of forming metal designs such as hot film sensors on a composite surface according to the present invention. The outer composite layer is an epoxy resin which is shaped to a desired surface on an underlying metal layer. The epoxy resin is bombarded with an ion beam for a brief period and then a fused silica layer is simultaneously vapor deposited thereon via an electron beam. The fused silica and epoxy resin form a dielectric over the metal layer. A sensor design mask is then positioned over the newly deposited fused silica. The exposed portion of the fused silica layer is then bombarded with an ion beam for a brief period of time and then a metal layer is simultaneously vapor deposited thereon via an electron beam. Thin film leads leading to a data acquisition system are then connected to the metal sensor and fused silica layer in a similar manner. All operations employing the ion beam and electron beam were conducted in a vacuum environment. NASA

**N93-19636#** Sandia National Labs., Albuquerque, NM.
**PIEZOELECTRIC RESPONSE OF PRECISELY POLED PVDF TO SHOCK COMPRESSION GREATER THAN 10 GPa**
F. Bauer (Institut Franco-Allemand de Recherches, Saint-Louis, France ), H. Lefebvre (Institut Franco-Allemand de Recherches, Saint-Louis, France), R. A. Graham, M. U. Anderson, R. P. Reed, and L. M. Lee (Ktech Corp., Albuquerque, NM.) 1992 5 p Presented at the 8th International Symposium on Applications of Ferroelectrics, Spokane, WA, 31 Aug. - 2 Sep. 1992
(Contract DE-AC04-76DP-00789)
(DE93-002469; SAND-92-2177C; CONF-9208183-1) Avail: CASI HC A01/MF A01

Prior work has shown that the piezoelectric response of shock-compressed PVDF film prepared with attention to mechanical and electrical processing exhibits precise, well-defined, reproducible behavior to 10 GPa. Higher pressure response continues to pressures approaching 50 GPa, and appears to provide a basis for a very high pressure stress-rate gauge. Previous work shows that differences in response were sometimes observed. The present report describes studies in progress undertaken to increase the precision of the polarization of the PVDF and to develop optimum sensors and shock gauge package designs. Results obtained on such careful prepared PVDF shock gauges show that differences in electrical charge response less than few percent are observed between 10 and 25 GPa. DOE

**N93-19651*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**2D VELOCITY AND TEMPERATURE MEASUREMENTS IN HIGH SPEED FLOWS BASED ON SPECTRALLY RESOLVED RAYLEIGH SCATTERING**
Richard G. Seasholtz 1992 12 p Presented at the Advanced Research Workshop: New Trends in Instrumentation for Hypersonic Research, Le Fauga-Mauzac, France, 27 Apr. - 1 May 1992; sponsored by NATO
(RTOP 505-62-50)
(NASA-TM-105784; E-7214; NAS 1.15:105784) Avail: CASI HC A03/MF A01

The use of molecular Rayleigh scattering for measurements of gas velocity and temperature is evaluated. Molecular scattering avoids problems associated with the seeding required by conventional laser anemometry and particle image velocimetry. The technique considered herein is based on the measurement of the spectrum of the scattered light. Planar imaging of Rayleigh scattering using a laser light sheet is evaluated for conditions at 30 km altitude (typical hypersonic flow conditions). The Cramer-Rao lower bounds for velocity and temperature measurement uncertainties are calculated for an ideal optical spectrum analyzer and for a planar mirror Fabry-Perot interferometer used in a static, imaging mode. With this technique, a single image of the Rayleigh scattered light from clean flows can be analyzed to obtain temperature and one component of velocity. Experimental results are presented for planar velocity measurements in a Mach 1.3 air jet. Author

**N93-19889*#** Swales and Associates, Beltsville, MD.
**OPTICAL/THERMAL ANALYSIS METHODOLOGY FOR A SPACE-QUALIFIABLE RTP FURNACE**
D. Bugby, S. Dardarian, and E. Cole (George Mason Univ., Fairfax, VA.) [1993] 11 p
(Grant NAG5-1495)
(NASA-CR-192254; NAS 1.26:192254) Avail: CASI HC A03/MF A01

A methodology to predict the coupled optical/thermal performance of a reflective cavity heating system was developed and a laboratory test to verify the method was carried out. The procedure was utilized to design a rapid thermal processing (RTP) furnace for the Robot-Operated Material Processing in Space (ROMPS) Program which is a planned STS HH-G canister experiment involving robotics and material processing in microgravity. The laboratory test employed a tungsten-halogen reflector/lamp to heat thin, p-type silicon wafers. Measurements instrumentation consisted of 5-mil Pt/Pt-Rh thermocouples and an optical pyrometer. The predicted results, utilizing an optical ray-tracing program and a lumped-capacitance thermal analyzer, showed good agreement with the measured data for temperatures exceeding 1300 C. Author

**N93-18467#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**NANORECORDING**
G. Eng, N. A. Ives, B. A. Morgan, and M. S. Leung *In its* Aerospace Sponsored Research 1 Dec. 1991 p 26-28 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18822*#** Phillips Lab., Edwards AFB, CA.
**SMART PATCH PIEZOCERAMIC ACTUATOR ISSUES**
Steven F. Griffin, Keith K. Denoyer, and Brad Yost *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 47-63 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

**N93-18842*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**OPTICAL PATHLENGTH CONTROL ON THE JPL PHASE B INTERFEROMETER TESTBED**
John T. Spanos and Zahidul H. Rahman *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 343-357 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

**N93-19880#** Technical Research Centre of Finland, Espoo. Instrument Lab.
**AIRBORNE IMAGING SPECTROMETER DEVELOPMENT TASKS**
John Bolten *In its* Airborne Remote Sensing 1991 p 61-73 (For primary document see N93-19871 06-43)
Copyright Avail: CASI HC A03/MF A01

**N93-19927#** British Aerospace Defence, Preston (England).
**DEVELOPMENT AND FLIGHT TESTING OF A SURFACE PRESSURE MEASUREMENT INSTALLATION ON THE EAP DEMONSTRATOR AIRCRAFT**
G. J. Watson *In* AGARD, Flight Testing Oct. 1992 13 p (For

primary document see N93-19901 06-05)
Copyright Avail: CASI HC A03/MF A04

## 36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

**N93-17894#** New Mexico Univ., Albuquerque. Center for High Technology Materials.
**OPTOELECTRONIC MATERIALS CENTER: A COLLABORATIVE PROGRAM INCLUDING UNIVERSITY OF NEW MEXICO, STANFORD UNIVERSITY, AND CALIFORNIA INSTITUTE OF TECHNOLOGY Quarterly Report, 1 Jan. - 31 Mar. 1991**
S. R. Brueck 15 May 1992 55 p
(Contract MDA972-90-C-0046; ARPA Order 7526)
(AD-A258113) Avail: CASI HC A04/MF A01

The Optoelectronic Materials Center is a collaborative program involving the University of New Mexico, Stanford University, and the California Institute of Technology. Sandia National Labs and MIT Lincoln Lab are also involved in this program under separate contract vehicles. This program emphasizes three main areas: diode-based visible sources, two-dimensional optical interconnects, and high-speed optoelectronics. Progress on individual tasks is very briefly discussed below. Several of the tasks will impact more than one of the above areas. For simplicity, the tasks are arranged by institution in an order roughly determined by the above areas. GRA

**N93-18008#** University Coll., Galway (Ireland).
**BACKSCATTER AND TRANSMISSION OF AEROSOL AT UV THROUGH MIDDLE IR WAVELENGTHS Interim Report No. 1, Sep. - Dec. 1992**
S. G. Jennings Dec. 1992 4 p
(Contract DAJA45-92-C-0024)
(AD-A258162; R/D-6798-EN-01) Avail: CASI HC A01/MF A01

A research scientist has commenced work under the contract. A Continuum Surelite 10 Hz Nd:YAG laser system which includes second, third, and fourth harmonic generators has been purchased and is currently being set up. In addition, a research assistant has also commenced work and is directed towards the measurement of biological aerosol components - pollen in the first instance. A special pollen sampler - a tauber trap - is currently being constructed with the objective of conducting long-term pollen field measurements. GRA

**N93-18068*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**APPLICATION OF LASER DOPPLER VELOCIMETER TO CHEMICAL VAPOR LASER SYSTEM**
Luther R. Gartrell, William W. Hunter, Jr., Ja H. Lee, Mark T. Fletcher, and Bagher M. Tabibi (Hampton Univ., VA.) Feb. 1993 22 p
(RTOP 505-59-54-03)
(NASA-TM-4409; L-17072; NAS 1.15:4409) Avail: CASI HC A03/MF A01

A laser Doppler velocimeter (LDV) system was used to measure iodide vapor flow fields inside two different-sized tubes. Typical velocity profiles across the laser tubes were obtained with an estimated +/-1 percent bias and +/-0.3 to 0.5 percent random uncertainty in the mean values and +/-2.5 percent random uncertainty in the turbulence-intensity values. Centerline velocities and turbulence intensities for various longitudinal locations ranged from 13 to 17.5 m/sec and 6 to 20 percent, respectively. In view of these findings, the effects of turbulence should be considered for flow field modeling. The LDV system provided calibration data for pressure and mass flow systems used routinely to monitor the research laser gas flow velocity. Author

**N93-18091*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A FUZZY LOGIC BASED CONTROLLER FOR THE AUTOMATED ALIGNMENT OF A LASER-BEAM-SMOOTHING SPATIAL FILTER**
M. J. Krasowski and D. E. Dickens (Dayton Univ., OH.) Dec. 1992 17 p
(RTOP 590-21-11)
(NASA-TM-105994; E-7526; NAS 1.15:105994) Avail: CASI HC A03/MF A01

A fuzzy logic based controller for a laser-beam-smoothing spatial filter is described. It is demonstrated that a human operator's alignment actions can easily be described by a system of fuzzy rules of inference. The final configuration uses inexpensive, off-the-shelf hardware and allows for a compact, readily implemented embedded control system. Author

**N93-18101#** Northeast Semiconductor, Inc., Ithaca, NY.
**INNOVATIVE TECHNIQUES FOR THE PRODUCTION OF LOW COST 2D LASER DIODE ARRAYS Monthly Technical Report No. 9, 1-30 Oct. 1992**
30 Nov. 1992 8 p
(Contract N00014-91-C-0222)
(AD-A258485) Avail: CASI HC A02/MF A01

The primary objective of this program is to develop a low cost, high yielding methodology for processing, packaging and characterization of MBE-grown two-dimensional high power laser diode arrays. Projected increases in overall yield of AlGaAs diode lasers would reduce manufacturing cost from the current $10 to $20 per peak watt to below $3 per peak watt. Emphasis will be placed on innovative packaging techniques that will utilize recent advances in diamond heat sinking technology. GRA

**N93-18234#** Phillips Lab., Kirtland AFB, NM.
**STABILIZED IODINE FLOW FOR LONG RUN TIME CHEMICAL OXYGEN-IODINE LASERS Final Report, 1 Oct. 1990 - 31 Jan. 1992**
M. P. Murdough and C. A. Helms Oct. 1992 29 p
(AD-A257760; AD-E201272; PL-TN-92-1005) Avail: CASI HC A03/MF A01

A computer-controlled iodine flow rate system has been built for the chemical oxygen-iodine laser. An optical measurement was used to determine iodine flow rate, and helium flow rate was varied to maintain a constant flow rate during long laser tests. The automated system worked well over a wide range of iodine flow rates and initial conditions. GRA

**N93-18277*** National Aeronautics and Space Administration. Pasadena Office, CA.
**SELF-COLLIMATED UNSTABLE RESONATOR SEMICONDUCTOR LASER Patent**
Robert J. Lang, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 12 Jan. 1993 8 p Filed 28 Aug. 1991 Supersedes 92N-17899 (30 - 8, p 1305)
(Contract NAS7-918)
(NASA-Case-NPO-18386-1-CU; US-Patent-5,179,568;
US-Patent-Appl-SN-751440; US-Patent-Class-372-95;
Int-Patent-Class-H01S-3/08) Avail: US Patent and Trademark Office

Self-collimation of the output is achieved in an unstable resonator semiconductor laser by providing a large concave mirror M sub 1 and a small convex mirror M sub 2 on opposite surfaces of a semiconductor body of a material having an effective index of refraction denoted by n, where the respective mirror radii R sub 1, R sub 2 and beam radii r sub 1, r sub 2 are chosen to satisfy a condition (R sub 2)/(1 + r sub 1) = (n - 1)/n, with a value of geometric magnification 1 less than or equal to M less than or equal to (n + 1)/(n - 1) where r sub 1 and r sub 2 are the radii of counterpropagating beams at respective mirrors of radii R sub 1 and R sub 2. Official Gazette of the U.S. Patent and Trademark Office

**N93-18287*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**DOPPLER SHIFT COMPENSATION SYSTEM FOR LASER TRANSMITTERS AND RECEIVERS Patent**
Geary K. Schwemmer, inventor (to NASA) 2 Feb. 1993 10 p Filed 21 Jun. 1989
(NASA-Case-GSC-13194-1; US-Patent-5,184,241;
US-Patent-Appl-SN-369171; US-Patent-Class-359-161;
US-Patent-Class-367-904; Int-Patent-Class-H04B-10/00) Avail: US Patent and Trademark Office

This patent relates to a laser transmitting and receiving system that includes doppler compensation for large doppler shifts in frequency caused by relative motion between a collocated transceiver and a target or relative motion between separated transmitters and receivers. The system includes a tunable laser, a dithered laser optical frequency standard, and a computer

for calculating the estimated Doppler shift at a given time using platform navigation and attitude control inputs as well as inputs relating to pointing data controlling the direction of transmission. The frequency standard and the computer output are employed to develop a Doppler compensation signal which may be used to shift the frequency of the laser transmitter or shift the bandpass of a laser receiver filter. The Doppler compensation is provided by a feedback loop which may include RF components, a timing trigger from the computer, or wavemeters.

Official Gazette of the U.S. Patent and Trademark Office

**N93-18429#** Universiteit Twente, Enschede (Netherlands).

**OPTICALLY PUMPED CONTINUOUS WAVE CF4 LASER Ph.D. Thesis**

Menno Hartemink 1991 140 p Sponsored by Ultra-Centrifuge Nederland N.V. and Nederlands Centrum voor Laser Research B.V.

(ISBN-90-9004442-6; ETN-92-92829) Avail: CASI HC A07/MF A02

The Continuous Wave (CW) CF4 laser, which emits at 16 microns, was investigated, and special attention was paid to the physical processes in this optically pumped gas laser. The experimenal set up of the CO2 pump laser and the CH4 laser is described. The experimental study of the absorption of the combination band as a function of temperature and pressure is described. The gain anisotropy of the optically pumped CW CF4 laser is considered, and the directional dependence of the gain, and thus of the emitted power, is described. The experimental study of the CW CF4 laser as a function of pressure and temperature is described. Experiments with a resonance enhanced low pressure optoacoustic cell are described. ESA

**N93-18448#** Stanford Linear Accelerator Center, CA.

**A Ti:SAPPHIRE LASER FOR THE NEW POLARIZED ELECTRON SOURCE**

J. Frisch, M. B. Woods, and M. Zolotorev Oct. 1992 3 p Presented at the 16th International LINAC Conference, Ottawa, Ontario, 23-28 Aug. 1992

(Contract DE-AC03-76SF-00515)

(DE93-004016; SU-SLAC-Pub-5950; CONF-9208109-68) Avail: CASI HC A01/MF A01

The SLAC polarized electron source uses a laser driven photo cathode gun. We have developed a Titanium Sapphire laser at SLAC to replace the dye laser currently used for the source. The new laser is designed to operate at wavelengths between 750 and 850 nm while producing 400 mJ of energy in 1.6 ns pulses at 120 Hz. Installation on the accelerator is expected in January of 1993. DOE

**N93-18512#** Brookhaven National Lab., Upton, NY.

**PHOTOEMISSION FROM Ag, Cu, AND CsI**

T. Srinivasan-Rao, J. Fischer, and T. Tsang Jun. 1992 12 p Presented at the Advanced Accelerator Concepts Workshop, Port Jefferson, NY, 14-20 Jun. 1992

(Contract DE-AC02-76CH-00016)

(DE93-001964; BNL-48004; CONF-9206193-16) Avail: CASI HC A03/MF A01

Photoemission characteristics of three different cathodes, CsI, Ag film, and Cu were investigated. CsI, upon irradiation by 213 nm, 10ps laser pulse yields a quantum efficiency of 4 percent at O.2 micro-J input energy. The saturation mechanism observed at higher input energies require further investigation. Ag film, upon irradiation by 630 nm, 300 fs laser emit prompt photoelectrons after absorbing 2 photons. There was no evidence of optical damage of the film up to 10(exp 11) W/sq cm. At low intensities, photoemission from Cu is a simple nu-e(exp -1) interaction, the nonlinearity of the process depending strongly on trace impurities. At higher intensities, there appears to be a change in the emission mechanism. DOE

**N93-18584*#** Maryland Univ., College Park. Dept. of Electrical Engineering.

**DEVELOPMENT OF SIMPLIFIED EXTERNAL CONTROL TECHNIQUES FOR BROAD AREA SEMICONDUCTOR LASERS Final Report**

Christopher C. Davis Feb. 1993 77 p

(Grant NAG5-1383)

(NASA-CR-192223; NAS 1.26:192223) Avail: CASI HC A05/MF A01

The goal of this project was to injection lock a 500 mW broad area laser diode (BAL) with a single mode low power laser diode with injection beam delivery through a single mode optical fiber (SMF). This task was completed successfully with the following significant accomplishments: (1) injection locking of a BAL through a single-mode fiber using a master oscillator and integrated miniature optics; (2) generation of a single-lobed, high-power far-field pattern from the injection-locked BAL that steers with drive current; and (3) a comprehensive theoretical analysis of a model that describes the observed behavior of the injection locked oscillator. Author

**N93-18605*#** Texas Univ., Austin. Center for Space Research.

**GEOPHYSICAL PARAMETERS FROM THE ANALYSIS OF LASER RANGING TO STARLETTE Semiannual Technical Report, 1 Aug. 1990 - 31 Jan. 1991**

B. E. Schutz, C. K. Shum, and B. D. Tapley 4 Apr. 1991 7 p

(Grant NAG5-757)

(NASA-CR-192406; NAS 1.26:192406) Avail: CASI HC A02/MF A01

The University of Texas Center for Space Research (UT/CSR) research efforts covering the time period from August 1, 1990 through January 31, 1991 have concentrated on the following areas: (1) Laser Data Processing (more than 15 years of Starlette data (1975-90) have been processed and cataloged); (2) Seasonal Variation of Zonal Tides (observed Starlette time series has been compared with meteorological data-derived time series); (3) Ocean Tide Solutions . (error analysis has been performed using Starlette and other tide solutions); and (4) Lunar Deceleration (formulation to compute theoretical lunar deceleration has been verified and applied to several tidal solutions). Concise descriptions of research achievement for each of the above areas are given. Copies of abstracts for some of the publications and conference presentations are included in the appendices. Author

**N93-18772*#** University of Central Florida, Orlando. Center for Research in Electro-Optics and Lasers.

**LASER DAMAGE OF HR, AR-COATINGS, MONOLAYERS AND BARE SURFACES AT 1064 nm Final Report**

S. V. Garnov (Academy of Sciences, USSR, Moscow ), S. M. Klimentov (Academy of Sciences, USSR, Moscow ), A. A. Said, and M. J. Soileau 10 Feb. 1993 22 p

(Grant NAG1-1322)

(NASA-CR-192156; NAS 1.26:192156) Avail: CASI HC A03/MF A01

Laser induced damage thresholds and morphologies were investigated in a variety of uncoated and coated surfaces, including monolayers and multi-layers of different chemical compositions. Both antireflective (AR) and highly reflective (HR) were tested. Testing was done at 1064 nm with 25 picosecond and 8 nanosecond YAG/Nd laser single pulses. Spot diameter in the experiments varied from 0.09 to 0.22 mm. The laser damage measurement procedure consisted of 1-on-1 (single laser pulse in the selected site) and N-on-1 experiments including repeated irradiation by pulses of the same fluence and subsequently raised from pulse to pulse fluence until damage occurred. The highest picosecond damage thresholds of commercially available coatings averaged 12 - 14 J/sq cm, 50 percent less than thresholds obtained in bare fused silica. Some coatings and bare surfaces revealed a palpable preconditioning effect (an increase in threshold of 1.2 to 1.8 times). Picosecond and nanosecond data were compared to draw conclusions about pulse width dependence. An attempt was made to classify damage morphologies according to the type of coating, class of irradiating, and damage level. Author

**N93-18994#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**DESIGN AND CHARACTERIZATION OF OPTICALLY PUMPED VERTICAL CAVITY SURFACE EMITTING LASERS M.S. Thesis**

Richard J. Bagnell Dec. 1992 116 p

(AD-A258815; AFIT/GE/ENP/92D-01) Avail: CASI HC A06/MF A02

Vertical Cavity Surface Emitting Lasers (VCSEL's) are a form of semiconductor laser which have their cavity oriented orthogonally to the plane of the wafer. The orientation necessitates short cavities, highly reflective mirrors and a relatively high gain/loss ratio. Even so, the resultant superior exit beam characteristics and the tight packing density of the finished lasers provide strong motivation for pursuing the growth of these structures. This thesis details the design of an optically pumped InGaAs multiple quantum well periodic gain structure VCSEL with a 950 nm lasing wavelength. These growths were to be a first attempt at VCSEL construction, so part of this study included verification of the quality of the parts of the finished design. These measurements required the construction of a laboratory configuration to optically pump VCSEL's and characterize them

by spectral reflectivity, output beam polarization, mode, lasing wavelength, and optimal pump wavelength. Analysis of the characteristics for several VCSEL's obtained from the University of Arizona, and the back mirror grown locally, illustrate tile ability to use measured data and theoretical spectral reflectivity calculations to determine the quality of the growths.
GRA

**N93-18996#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**LASER PHASE FRONT MEASUREMENTS USING A PHASE CONJUGATE TWYMAN-GREEN INTERFEROMETER M.S. Thesis**
William J. Mandeville Dec. 1992 52 p
(AD-A258821; AFIT/GEP/ENP/92-D-08) Avail: CASI HC A04/MF A01

This study demonstrated the use of a phase conjugate TwymanGreen interferometer for measuring the phase fronts of beams emitted by infrared diode lasers operating at 830 nm. This interferometer successfully measured the phase front of a single element diode laser, providing better resolution than its conventional counterpart. The phase conjugate mirror compensated for aberrations introduced by imperfect optics in the phase conjugating arm of the interferometer. This interferometer was unable to measure the phase front of a diode array due to the array's inability to create a phase conjugate return. The array's short coherence length is believed to be the main cause preventing the phase conjugate return.
GRA

**N93-19372#** Multilayer Optics and X-ray Technology, Inc., Provo, UT.
**INEXPENSIVE CAPILLARY DISCHARGE X RAY LASER DRIVER, PHASE 1 Initial Technical Report**
A. M. Panin 27 Nov. 1992 5 p
(Contract N00014-92-C-2218)
(AD-A259032) Avail: CASI HC A01/MF A01

A fully-implicit code to time-advance the 1-D magnetohydrodynamics (MHD) equations was developed specifically for modeling a capillary discharge (a radial dependence of parameters). Classical transport is assumed to have the correct dependence to within a multiplicative factor that can be specified at run-time. The atomic physics of the plasma is modeled using O-D approximation where an 'average' temperature and density are used to determine the ionization and recombination rates for the principal plasma species. These rates are then used to determine an effective z for the MHD model. It is assumed that the entire plasma is ionized to the same state. The model can currently treat elements up to z = 18 (argon) due to limitations in the atomic physics portion of the code. This was tested using some published data from carbon cappillaries and the best fit corrections to classical transport were determined for that type of discharge. Normalization of the code for an argon plasma was not done due to a lack of published experimental capillary discharge data.
Author

**N93-19373*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**METHOD AND APPARATUS FOR DETECTION AND CONTROL OF PRELASING IN A Q-SWITCHED LASER Patent Application**
George E. Lockard, inventor (to NASA) 3 Dec. 1992 19 p
(NASA-Case-LAR-14790-1; NAS 1.71:LAR-14790-1;
US-Patent-Appl-SN-988082) Avail: CASI HC A03/MF A01

The present invention detects prelasing in a Q-switch laser and terminates laser operation upon such detection. A detector senses the presence of light beyond a Q-switch and generates an appropriate electrical signal. A comparison stage circuit compares this detector signal with an established threshold value indicative of prelasing and generates a trigger signal if this detector signal exceeds this threshold value. A control stage circuit receives both this trigger value and a sampled Q-switch signal indicative of an opening of the Q-switch. The control stage circuit terminates operation of the laser if the trigger signal from the comparison stage is received while the sampled Q-switch signal is being received to avoid the effects of prelasing. Appropriate delays and timing sequencies are established.
NASA

**N93-19506#** Columbia Univ., New York, NY. Dept. of Applied Physics.
**AN INVERSE FREE ELECTRON LASER ACCELERATOR EXPERIMENT**
I. Wernick and T. C. Marshall 1992 7 p Presented at the Advanced Accelerator Concepts Workshop, Port Jefferson, NY, 14-20 Jun. 1992
(Contract DE-FG02-91ER-40669)
(DE93-003495; CONF-9206193-18) Avail: CASI HC A02/MF A01

A free electron laser was configured as an autoaccelerator to test the principle of accelerating electrons by stimulated absorption of radiation (lambda = 1.65 mm) by an electron beam (750 kV) traversing an undulator. Radiation is produced in the first section of a constant period undulator (l(sub w1) = 1.43 cm) and then absorbed (approximately 40 percent) in a second undulator, having a tapered period (l(sub w2) = 1.8 - 2.25 cm), which results in the acceleration of a subgroup (approximately 9 percent) of electrons to approximately 1 MeV.
DOE

**N93-19515#** Argonne National Lab., IL.
**LASER BEAM DIAGNOSTICS FOR KILOWATT POWER PULSED YAG LASER**
Yi Liu and Keng H. Leong 1992 11 p Presented at the International Congress on Application of Laser and Electro-Optics, Orlando, FL, 25-29 Oct. 1992
(Contract W-31-109-eng-38)
(DE93-002928; ANL/EP/CP-76192; CONF-9210217-1) Avail: CASI HC A03/MF A01

There is a growing need for high power YAG laser beam diagnostics with the recent introduction of such lasers in laser material processing. In this paper, we will describe the use of a commercially available laser beam analyzer (Prometec) to profile the laser beam from a 1600 W pulsed Nd:YAG laser that has a 1 mm fiber optic beam delivery system. The selection of laser pulse frequency and pulse width for the measurement is discussed. Laser beam propagation parameters by various optical components such as fibers and lenses can be determined from measurements using this device. The importance of such measurements will be discussed.
DOE

**N93-19626#** California Univ., Berkeley. Lawrence Berkeley Lab.
**PHYSICALLY TRANSPARENT FORMULATION OF A FREE-ELECTRON LASER IN THE LINEAR GAIN REGIME**
W. A. Barletta (Los Alamos National Lab., NM.), A. M. Sessler, and L. H. Yu (Brookhaven National Lab., Upton, NY.) Aug. 1992 14 p Presented at the 14th International Free Electron Laser Conference, Kobe, Japan, 23-28 Aug. 1992
(Contract DE-AC03-76SF-00098)
(DE93-002577; LBL-32221; CONF-9208142-8; UCRL-JC-110770; ESG-181) Avail: CASI HC A03/MF A01

The recent 2-dimensional analytic theories of a free-electron laser (FEL) in the linear regime are reformulated in terms of three dimensionless ratios that describe the degree to which the characteristics of the electron beam deviate from the cold beam limit of a beam with no emittance or energy spread. In terms of these ratios, algebraic model equations of a fit that combines features of both of the 2-dimensional analyses are given as a convenient computational tool. Graphs of the FEL gain eigenvalue computed with the combined 2-D formulation illustrate that the gain and the output power at saturation are reduced from the 1-D value, when any of the ratios is larger than unity.
DOE

**N93-19745#** California Univ., Berkeley. Lawrence Berkeley Lab.
**SUPPRESSION OF MODE-BEATING IN A SATURATED HOLE-COUPLED FEL OSCILLATOR**
S. Krishnagopal, M. Xie, and K. J. Kim Aug. 1992 15 p Presented at the 14th International Free Electron Laser Conference, Kobe, Japan, 23-28 Aug. 1992
(Contract DE-AC03-76SF-00098)
(DE93-002554; LBL-32223; CONF-9208142-12; ESG-183) Avail: CASI HC A03/MF A01

In a hole-coupled resonator, either empty or loaded with a linear FEL gain medium, the phenomenon of mode-degeneracy and mode-beating were studied. When the magnitudes of the eigenvalues, derived from a linear analysis, are equal for two or more dominant eigenmodes, the system cannot achieve a stable beam-profile. We investigate this phenomenon when a saturated FEL is present within the cavity, thus introducing non-linearity. We use a three-dimensional FEL oscillator code, based on the amplifier code TDA, and show that mode-beating is completely suppressed in the nonlinear saturated regime. We suggest a simple, qualitative model for the mechanism responsible for this suppression.
DOE

**N93-19747#** California Univ., Berkeley. Lawrence Berkeley Lab.
**THE MULTI-CAVITY FREE-ELECTRON LASER**
S. Krishnagopal, G. Rangarajan, and A. Sessler Jul. 1992 27 p Presented at the 14th International Free Electron Laser Conference, Kobe, Japan, 23-28 Aug. 1992
(Contract DE-AC03-76SF-00098)
(DE93-002569; LBL-32220; CONF-9208142-10; ESG-180) Avail: CASI HC A03/MF A01

Consideration is made of a free-electron laser with many optical cavities where the cavities communicate with each other, not optically, but through the electron beam. Analysis is made in the one-dimensional approximation. A general expression is given for the growth rate in the exponential (high current) regime. In the regime where lethargy is important, expressions are given in the two opposite limits of small and large numbers of cavities and bunches. Numerical simulation results, still in the one-dimensional approximation, but including non-linearities, are presented. The multi-cavity free-electron laser (MC/FEL) can be employed to avoid the slippage phenomena, and thus to make picosecond pulses of infra-red radiation. Three examples of this application are presented. DOE

**N93-19895#** California Univ., Berkeley. Lawrence Berkeley Lab.
**DESIGN OF RF CONDITIONER CAVITIES**
R. Govil, R. A. Rimmer, A. Sessler, and H. G. Kirk Jun. 1992 20 p Presented at the 14th International Free Electron Laser Conference, Kobe, Japan, 23-28 Aug. 1992
(Contracts DE-AC03-76SF-00098; DE-AC02-76CH-00016)
(DE93-002576; LBL-32232; CONF-9208142-9; ESG-184) Avail: CASI HC A03/MF A01

Theoretical studies are made of radio frequency structures which can be used to condition electron beams so as to greatly reduce the stringent emittance requirements for successful lasing in a free-electron laser. The basic strategy of conditioning calls for modulating an electron beam in the transverse dimension, by a periodic focusing channel, while it traverses a series of RF cavities, each operating in a TM(sub 210) mode. In this paper, we analyze the cavities both analytically and numerically (using MAFIA simulations). We find that when cylindrical symmetry is broken the coupling impedance can be greatly enhanced. We present results showing various performance characteristics as a function of cavity parameters, as well as possible designs for conditioning cavities. DOE

**N93-19950#** Technion - Israel Inst. of Tech., Haifa.
**THE LASING MECHANISM OF THE ORBITRON: A MILLIMETER-WAVE MASER BASED ON A GLOW DISCHARGE Final Report, 1 Sep. 1988 - 30 Apr. 1992**
Joshua Felsteiner Oct. 1992 31 p
(Grant AF-AFOSR-0343-88)
(AD-A258680; AFOSR-93-01TR) Avail: CASI HC A03/MF A01

In this work it was found that the Orbitron microwave generation follows a much stronger generation of RF oscillations close to the ion plasma frequency. This phenomenon is associated with instability of the cathode sheath which causes a modulation of the discharge current of almost 100 percent. These intense RF oscillations are accompanied by short microwave spikes, each emitted at the same phase of the RF period. The microwave radiation has a wide spectrum above the electron plasma frequency. This radiation appears to be due to the transformation of electrostatic plasma waves which were measured inside the plasma and are assumed to be driven by the beam-plasma instability. Both RF and microwave generation do not depend on the anode shape, area, or position. GRA

**N93-19952*#** Massachusetts Univ., Amherst. Dept. of Electrical and Computer Engineering.
**DIRECT SOLAR PUMPING OF SEMICONDUCTOR LASERS: A FEASIBILITY STUDY Semiannual Progress Report, 1 Jun. 1990 - 1 Mar. 1991**
Neal G. Anderson 1 Mar. 1991 5 p
(Grant NAG1-1148)
(NASA-CR-192184; NAS 1.26:192184) Avail: CASI HC A01/MF A01

The primary goals of the feasibility study are the following: (1) to provide a preliminary assessment of the feasibility of pumping semiconductor lasers in space directly focused sunlight; and (2) to identify semiconductor laser structures expected to operate at the lowest possible focusing intensities. It should be emphasized that the structures under consideration would provide direct optical-to-optical conversion of sunlight into laser light in a single crystal, in contrast to a configuration consisting of a solar cell or battery electrically pumping a current injection laser. With external modulation, such lasers may prove to be efficient sources for intersatellite communications. We proposed to develop a theoretical model of semiconductor quantum-well lasers photopumped by a broadband source, test it against existing experimental data where possible, and apply it to estimating solar pumping requirements and identifying optimum structures for operation for operation at low pump intensities. This report outlines our progress toward these goals. Discussion of several technical details are left to the attached summary abstract. Derived from text

**N93-18469#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**HIGH-ENERGY LASER-PARTICLE INTERACTION**
D. W. Pack *In its* Aerospace Sponsored Research 1 Dec. 1991 p 34-39 (For primary document see N93-18459 06-99)
Avail: CASI HC A02/MF A02

**N93-18470#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**TRANSITION DYNAMICS AND GUEST-HOST INTERACTIONS IN LASER MATERIALS**
T. S. Rose *In its* Aerospace Sponsored Research 1 Dec. 1991 p 40-43 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18472#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**NOVEL SHORT-WAVELENGTH LASERS**
J. M. Herbelin *In its* Aerospace Sponsored Research 1 Dec. 1991 p 46-48 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18473#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**TUNABLE INFRARED AND VISIBLE SOLID-STATE LASER**
D. Chen *In its* Aerospace Sponsored Research 1 Dec. 1991 p 48-50 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-19435*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. TDA Mission Support and DSN Operations.
**AVAILABILITY ANALYSIS OF THE TRAVELING-WAVE MASER AMPLIFIERS IN THE DEEP SPACE NETWORK. PART 1: THE 70-METER ANTENNAS**
T. N. Issa *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 263-277 (For primary document see N93-19413 06-32)
(RTOP 314-40-21-30-02)
Avail: CASI HC A03/MF A03

**N93-19926#** Aerospatiale, Toulouse (France).
**USE OF A TRIAXIAL LASER VELOCIMETER FOR ANEMOMETRIC CALIBRATION ON AN A340 AIRBUS [UTILISATION D'UN VELOCIMETRE LASER TRIAXE POUR CALIBRATION ANEMOMETRIQUE SUR AIRBUS A340]**
F. Cattin-Valsecchi and C. Lopez *In* AGARD, Flight Testing Oct. 1992 10 p In FRENCH (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A02/MF A04

## 37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

**N93-17938#** Naval Postgraduate School, Monterey, CA.
**DESIGN AND CONTROL OF A SPACE BASED TWO LINK MANIPULATOR WITH LYAPUNOV BASED CONTROL LAWS M.S. Thesis**

Dennis Sorensen Sep. 1992 128 p
(AD-A257568) Avail: CASI HC A07/MF A02

The Flexible Spacecraft Simulator (FSS) at the Naval Postgraduate School was modified by replacing the flexible appendage with a two link robotic manipulator. This experimental setup was designed to simulate motion of a spacecraft about the pitch axis. The spacecraft consists of a main body, a two link manipulator, and a momentum wheel with an actuator to control the pitch attitude of the spacecraft. Position information from the main body and manipulators were obtained from Rotary Variable Displacement Transducers (RVDT's). The equations of motion were developed assuming that the main body and manipulator were rigid bodies. The resulting coupled, nonlinear, time variant equations of motion were used to analyze the dynamics and kinematics of the body, manipulator as well as the interaction between the two. Three different control strategies were developed using Lyapunov's Second or Direct Method. With the first controller, simple linear feedback of position and velocity information with constant gains was used to position the manipulator and stabilize the main body. A fifth order polynomial was used to generate a reference trajectory for the second controller. This trajectory was used in conjunction with a tracking Lyapunov controller to position and stabilize the system. In the third controller, a near-minimum-time technique was used to generate a reference trajectory. This reference trajectory was employed to design a tracking controller similar to that used in the polynomial reference controller. GRA

**N93-17956** ESDU International Ltd., London (England).
**EJECTORS AND JET PUMPS: COMPUTER PROGRAM FOR DESIGN AND PERFORMANCE FOR COMPRESSIBLE GAS FLOW**
Dec. 1992 45 p
(ESDU-92042; ISBN-0-85679-852-5) Avail: ESDU

ESDU 92042 introduces a FORTRAN program (available as ESDUpac A9242) for the design or performance assessment of ejectors (or jet pumps) in which the primary and secondary flows are of the same gas. It uses the methods of ESDU 84029 which provides two approaches to design. The quick design method is based on an analysis of experimental data for single-nozzle designs and, given a minimum of input (selection of entry and required exit pressures, temperatures, mass flow rate and dimensions), will calculate primary nozzle and exit dimensions. The detailed design method, based on one-dimensional flow equations that are detailed, applies also to multi- and annular-nozzle designs. In addition to the input for the quick method, it requires loss factors (in the primary and secondary nozzles, mixing duct and contraction or diffuser) and acceptable maximum design values for four parameters, but will calculate flow conditions throughout the ejector. The performance assessment method for an existing design, also based on the one-dimensional flow equations, calculates conditions throughout the ejector and at exit given the geometry, loss factors and a range of entry conditions. The use of the three methods is illustrated in a worked example. The program is provided as source code with file input/output or compiled within a user-friendly shell that prompts for data, both on disc for PC DOS systems. ESDU

**N93-17975*#** Georgia Inst. of Tech., Atlanta. Boom and Chassis Group.
**[ACTIVITIES OF THE BOOM AND CHASSIS GROUP]**
Jason Scott Dell, Thomas Bayne Meeks, Kelly Merkel, Brent Nelson, and Tom Winchell 1992 116 p
(Contract NASw-4435)
(NASA-CR-192028; NAS 1.26:192028) Avail: CASI HC A06/MF A02

Group One of the NASA Lunar Enabler Project has designed the primary chassis and boom structures for the lunar vehicle. Both components also feature V-clamps that were adapted to interface connections within the structure. The chassis features a front end, rear end section, middle cross-section, and face plate. The rear section contains an extra compartment for the engine, hydraulic pump, fuel bottles, and oil reservoir necessary for the wheel drives. Each section consists of tubular aluminum 6061-T6. The boom features four degrees of freedom system, where the minimum factor of safety of any part is 1.5 (but, normally much higher). It consists of a tapered upper boom, lower boom, and three elbows that complement the articulation joints. Each section of the boom has been constructed from aluminum 6061-T6. There are four joints and eight V-clamps in the boom assembly. The V-clamps feature support rings that prevent axial rotation. They provide easy adaptability and assembly. Author

**N93-17980#** Naval Postgraduate School, Monterey, CA.
**MOTION PLANNING FOR RIGID BODY ROBOTS M.S. Thesis**
Liek F. Tan Jun. 1992 131 p
(AD-A257557) Avail: CASI HC A07/MF A02

Given a non-holonomic disc robot D, its motion constraints in terms of maximum curvature (Kmax) and rate of change of curvature (Kmax), a set W of rectilinear polygonal obstacles which assemble an office-like environment, and two configurations S and G in free(W), this thesis investigates the planning of a smooth free path which satisfies the following condition: D is allowed backing up motions at the end portions of the path, but the middle portion is to be of class C2 in its entirety. Although the motion planning problem of D amidst polygonal obstacles has been extensively studied, the paths considered are mostly class C1 and piecewise C2 only, and are subject only to the Kmax constraint. Typically, such paths consist of straight line segments and circular arcs which have curvature discontinuity at the junction points. In order for E to follow such paths physically, D has to stop abruptly at each junction point to change curvature. The C2 path investigated in this thesis allows non-stopping motion of D. It is also subject to a further Kmax, constraint to avoid turns that exceed the rate of change of curvature constraint. GRA

**N93-17998** ESDU International Ltd., London (England).
**MINIMUM SIZE OF DISC CAMS WITH RADIAL TRANSLATING ROLLER FOLLOWERS**
Nov. 1992 40 p Supersedes ESDU-87014
(ESDU-92005; ISBN-0-85679-810-X) Avail: ESDU

ESDU 92005 gives a direct method for finding the minimum allowable prime circle radius based on the criteria that the maximum pressure angle does not exceed a specified value and that profile undercutting is avoided. ESDU 82023 provides an alternative approach that handles offset followers as well, but it is a geometric iterative procedure. Two methods are given here: one finds the minimum radius and the corresponding maximum diameter of the roller follower while the other finds the minimum radius when the size of the follower is known. The methods apply to DRD or DRRD follower motion defined by a single law; a hand calculation may be used based on graphs provided, or a FORTRAN program (ESDUpac A9205) which is also supplied, and both apply to six cam laws (simple harmonic, cycloidal, modified trapezoidal acceleration, modified sine acceleration, and 3-4-5 or 4-5-6-7 polynomial). Notes on the derivation of the method are included, together with step-by-step design procedures and guidance on the use of the program with a detailed explanation of the input and the output. Worked examples illustrate the practical applications of the procedures during the design of such mechanism. ESDU

**N93-18002#** Woods Hole Oceanographic Inst., MA.
**KINEMATIC EVALUATION OF END EFFECTOR DESIGN M.S. Thesis**
Gary W. Edwards Sep. 1992 83 p
(Contract N00123-89-G-0580)
(AD-A257519) Avail: CASI HC A05/MF A01

The complex, many degree-of-freedom end effectors at the leading edge of technology would be unusable in the sea bottom research environment. Simpler designs are required to provide adequate reliability for subsea use. This work examines selection of end effector designs to achieve optimum grasping ability with minimal mechanical complexity. A new method of calculating grasp stability is developed, incorporating elements of previous works in the field. Programs are developed which evaluate the ability of different end effector configurations to grasp representative objects (a cube, sphere, and infinite cylinder). End effector designs considered had circular palms with fingers located at the periphery, oriented so that each pointed to the center of the palm. The program tested configurations of from 1 to 4 fingers and from 1 to 3 links per finger. Three sets of finger proportions were considered: equal length links, half length links, and anthropomorphic proportions. The 2 finger, 2 link per finger configuration was determined to be the optimum design, and the half length proportions were selected as the best set of proportions. GRA

**N93-18015*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
**PRESSURIZED LUNAR ROVER**
Kenneth Creel, Jeffrey Frampton, David Honaker, Kerry McClure, and Mazyar Zeinali May 1992 106 p Original contains color illustrations

(Contract NASw-4435)
(NASA-CR-192034; NAS 1.26:192034) Avail: CASI HC A06/MF A02; 2 functional color pages

The pressurized lunar rover (PLR) consists of a 7 m long, 3 m diameter cylindrical main vehicle and a trailer which houses the power and heat rejection systems. The main vehicle carries the astronauts, life support systems, navigation and communication systems, directional lighting, cameras, and equipment for exploratory experiments. The PLR shell is constructed of a layered carbon-fiber/foam composite. The rover has six 1.5 m diameter wheels on the main body and two 1.5 m diameter wheels on the trailer. The wheels are constructed of composites and flex to increase traction and shock absorption. The wheels are each attached to a double A-arm aluminum suspension, which allows each wheel 1 m of vertical motion. In conjunction with a 0.75 m ground clearance, the suspension aids the rover in negotiating the uneven lunar terrain. The 15 N-m torque brushless electric motors are mounted with harmonic drive units inside each of the wheels. The rover is steered by electrically varying the speeds of the wheels on either side of the rover. The PLR trailer contains a radiosotope thermoelectric generator providing 6.7 kW. A secondary back-up energy storage system for short-term high-power needs is provided by a bank of batteries. The trailer can be detached to facilitate docking of the main body with the lunar base via an airlock located in the rear of the PLR. The airlock is also used for EVA operation during missions. Life support is a partly regenerative system with air and hygiene water being recycled. A layer of water inside the composite shell surrounds the command center. The water absorbs any damaging radiation, allowing the command center to be used as a safe haven during solar flares. Guidance, navigation, and control are supplied by a strapdown inertial measurement unit that works with the on-board computer. Star mappers provide periodic error correction. The PLR is capable of voice, video, and data transmission. It is equipped with two 5 W X-band transponder, allowing simultaneous transmission and reception. An S-band transponder is used to communicate with the crew during EVA. The PLR has a total mass of 6197 kg. It has a nominal speed of 10 km/hr and a top speed of 18 km/hr. The rover is capable of towing 3 metric tons (in addition to the RTG trailer). Author

**N93-18016*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
**DESIGN OF A PRESSURIZED LUNAR ROVER Final Report**
Manoj Bhardwaj, Vatsal Bulsara, David Kokan, Shaun Shariff, Eric Svarverud, and Richard Wirz 24 Apr. 1992 110 p Original contains color illustrations
(Contract NASw-4435)
(NASA-CR-192033; NAS 1.26:192033) Avail: CASI HC A06/MF A02; 3 functional color pages

A pressurized lunar rover is necessary for future long-term habitation of the moon. The rover must be able to safely perform many tasks, ranging from transportation and reconnaissance to exploration and rescue missions. Numerous designs were considered in an effort to maintain a low overall mass and good mobility characteristics. The configuration adopted consists of two cylindrical pressure hulls passively connected by a pressurized flexible passageway. The vehicle has an overall length of 11 meters and a total mass of seven metric tons. The rover is driven by eight independently powered two meter diameter wheels. The dual-cylinder concept allows a combination of articulated frame and double Ackermann steering for executing turns. In an emergency, the individual drive motors allow the option of skid steering as well. Two wheels are connected to either side of each cylinder through a pinned bar which allows constant ground contact. Together, these systems allow the rover to easily meet its mobility requirements. A dynamic isotope power system (DIPS), in conjunction with a closed Brayton cycle, supplied the rover with a continuous supply of 8.5 kW. The occupants are all protected from the DIPS system's radiation by a shield of tantalum. The large amount of heat produced by the DIPS and other rover systems is rejected by thermal radiators. The thermal radiators and solar collectors are located on the top of the rear cylinder. The solar collectors are used to recharge batteries for peak power periods. The rover's shell is made of graphite-epoxy coated with multi-layer insulation (MLI). The graphite-epoxy provides strength while the thermally resistant MLI gives protection from the lunar environment. An elastomer separates the two materials to compensate for the thermal mismatch. The communications system allows for communication with the lunar base with an option for direct communication with earth via a lunar satellite link. The various links are combined into one signal broadcast in the S-band at 2.3 GHz. The rover is fitted with a parabolic reflector disk for S-band transmission, and an omnidirectional antenna for local extravehicular activity (EVA) communication. The rover's guidance, navigation, and control subsystem consists of an inertial guidance system, an orbiting lunar satellite, and an obstacle avoidance system. In addition, the rover is equipped with a number of external fixtures including two telerobotic arms, lights, cameras, EVA storage, manlocks, a docking fixture, solar panels, thermal radiators, and a scientific airlock. In conclusion, this rover meets all of the design requirements and clearly surpasses them in the areas of mobility and maneuverability. Author

**N93-18039*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**THE ENABLER: A REEVALUATION OF DESIGN CONCEPTS AND CONSTRUCTION OF A SCALED MODEL**
David Bess, Stephen Fye, Thomas Gale, Dean Haldopolous, Michael Looney, Ken Milam, Dan Smith, and Frank Sosebee 8 Jun. 1992 24 p
(Contract NASw-4435)
(NASA-CR-192061; NAS 1.26:192061) Avail: CASI HC A03/MF A01

The basic objective of the student's work this quarter was to make an in depth examination of the design concepts used on the lunar vehicle 'The Enabler'. Several changes were made to the vehicle including a redesigned wheel, a more compact boom and a reduced articulation angle. The vehicle's final dimensions were determined through an optimization process by defining mathematical equations for several of the vehicle's defined objectives. These included the ability to scale a one meter object, traverse a one meter crevice, and maintain a wheel-to-wheel clearance of three inches while at maximum articulation. The final dimensions of the vehicle were used to construct an approximate 1/4 scale model of the chassis and wheels. The boom, however, was constructed on a 1/5 scale (from the original design). This was due to the redesign of the boom and the limitations of the constructing material and PVC fittings. Author

**N93-18041** ESDU International Ltd., London (England).
**BLENDING PROFILES OF DISC CAMS WITH RADIAL TRANSLATING ROLLER FOLLOWERS. PART 1: TO REDUCE SEGMENT ANGLE, REDUCE REFERENCE CIRCLE RADIUS OR INCREASE FOLLOWER LIFT**
Nov. 1992 37 p Supersedes in part ESDU 87014
(ESDU-92014; ISBN-0-85679-819-3) Avail: ESDU

ESDU 92014 gives methods for designing blended cam profiles meeting the criteria that the maximum pressure angle does not exceed a specified value and that profile undercutting is avoided. Each rise or return motion segment is formed by blending components of two single-law segments at the point of maximum follower velocity. A hand calculation may be used, with the graphical data of ESDU 92005, or the FORTRAN program provided as ESDUpac A9214; both apply to six commonly used cam laws. The input is the chosen pressure angle, roller diameter, and blending ratio; also two out of segment angle, reference circle radius and follower lift are input and the optimum value of the third is found. The advantages increase with blending ratio and unblended segment angle but incur a decreased minimum profile convex radius of curvature and increased peak acceleration away from the cam. The program allows a set of blending ratio values to be explored and, once a suitable value has been chosen, the program can be run in another mode to give full details of the cam profile and follower motion. The theoretical background is fully explained, step-by-step design procedures are provided, and the input to and output from the program are illustrated with fully worked examples. ESDU 83027 is complementary and presents an alternative hand calculation method of blending applicable to cams driving either translating or swinging arm followers. ESDU

**N93-18047*#** Minnesota Univ., Minneapolis. Dept. of Aerospace Engineering and Mechanics.
**CONCEPTUAL DESIGN OF A MARS TRANSPORTATION SYSTEM Final Design Report**
11 Aug. 1992 165 p
(Contract NASw-4435)
(NASA-CR-192039; NAS 1.26:192039) Avail: CASI HC A08/MF A02

In conjunction with NASA Marshall Space Flight Center and several

major aerospace corporations the University of Minnesota has developed a scenario to place humans on Mars by the year 2016. The project took the form of a year-long design course in the senior design curricula at the University's Aerospace Engineering and Mechanics Department. Students worked with the instructor, teaching assistants and engineers in industry to develop a vehicle and the associated mission profile to fulfill the requirements of the Mars Transportation System. This report is a summary of the final design and the process though which the final product was developed.
Author

**N93-18050*#** Universities Space Research Association, Houston, TX. Advanced Design Program.
**ENABLER OPERATOR STATION**
Andrea Bailey, John Keitzman, Shirlyn King, Rae Stover, and Torsten Wegner [1992] 10 p
(Contract NASw-4435)
(NASA-CR-192067; NAS 1.26:192067) Avail: CASI HC A02/MF A01

The objective of this project was to design an onboard operator station for the conceptual Lunar Work Vehicle (LWV). This LWV would be used in the colonization of a lunar outpost. The details that follow, however, are for an earth-bound model. Several recommendations are made in the appendix as to the changes needed in material selection for the lunar environment. The operator station is designed dimensionally correct for an astronaut wearing the current space shuttle EVA suit (which includes life support). The proposed operator station will support and restrain an astronaut as well as provide protection from the hazards of vehicle rollover. The threat of suit puncture is eliminated by rounding all corners and edges. A step-plate, located at the front of the vehicle, provides excellent ease of entry and exit. The operator station weight requirements are met by making efficient use of grid members, semi-rigid members and woven fabrics.
Author

**N93-18051*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**MECHANICAL DESIGN ENGINEERING ENABLER PROJECT WHEEL AND WHEEL DRIVES**
Richard E. Nutt, Britt K. Couch, John L. Holley, Jr., Eric S. Garris, and Paul V. Staut [1992] 41 p
(Contract NASw-4435)
(NASA-CR-192060; NAS 1.26:192060; ME-4182) Avail: CASI HC A03/MF A01

Our group was assigned the responsibility of designing the wheel and wheel drive system for a proof-of-concept model of the lunar-based ENABLER. ENABLER is a multi-purpose, six wheeled vehicle designed to lift and transport heavy objects associated with the construction of a lunar base. The resulting design was based on the performance criteria of the ENABLER. The drive system was designed to enable the vehicle to achieve a speed of 7 mph on a level surface, climb a 30 percent grade, and surpass a one meter high object and one meter wide crevice. The wheel assemblies were designed to support the entire weight of the vehicle on two wheels. The wheels were designed to serve as the main component of the vehicle's suspension and will provide suitable traction for lunar-type surfaces. The expected performance of the drive system for the ENABLER was influenced by many mechanical factors. The expected top speed on a level sandy surface is 4 mph instead of the desired 7 mph. This is due to a lack of necessary power at the wheels. The lack of power resulted from dimension considerations that allowed only an eight horsepower engine and also from mechanical inefficiencies of the hydraulic system. However, the vehicle will be able to climb a 30 percent grade, surpass a one meter high object and one meter wide crevice. The wheel assemblies will be able to support the entire weight of the vehicle on two wheels. The wheels will also provide adequate suspension for the vehicle and sufficient traction for lunar-type surfaces.
Author

**N93-18052*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**BOOM AND CHASSIS ARTICULATION JOINTS Final Report**
Joel T. Murphy, Jr., Vien Nguyen, Bonnie Turner, Bobby Wheeler, and Kimberlyn Williams 4 Jun. 1992 30 p
(Contract NASw-4435)
(NASA-CR-192059; NAS 1.26:192059; ME-4182) Avail: CASI HC A03/MF A01

The primary goal of our design project was to develop articulation joints for the chassis and boom of the proof-of-concept lunar vehicle. This is an ongoing project and the work of previous student groups was extensively reviewed. Some of the ideas generated are variations of past proposals. Although the project is funded by NASA/USRA, it is totally a student design effort.
Author

**N93-18062*#** Georgia Inst. of Tech., Atlanta. Controls Group.
**MECHANICAL ENGINEERING DESIGN PROJECT REPORT: ENABLER CONTROL SYSTEMS**
Christian Cullen, Dave DelVecchio, Alan Scarborough, and Andrew A. Havics 11 Jun. 1992 46 p
(Contract NASw-4435)
(NASA-CR-192058; NAS 1.26:192058; ME-4182) Avail: CASI HC A03/MF A01

The Controls Group was assigned the responsibility for designing the Enabler's control system. The requirement for the design was that the control system must provide a simple user interface to control the boom articulation joints, chassis articulation joints, and the wheel drive. The system required controlling hydraulic motors on the Enabler by implementing 8-bit microprocessor boards. In addition, feedback to evaluate positions and velocities must be interfaced to provide the operator with confirmation as well as control.
Author

**N93-18102*#** Idaho Univ., Moscow. Dept. of Mechanical Engineering.
**PLANETARY SURFACE EXPLORATION: MESUR/AUTONOMOUS LUNAR ROVER**
Larry Stauffer, Matt DiLorenzo, Dave Austin, Raymond Ayers, David Burton, Joe Gaylord, Jim Kennedy, Dale Lentz, Richard Laux, and Preston Nance et al Jun. 1992 73 p
(Contract NASw-4435)
(NASA-CR-192073; NAS 1.26:192073) Avail: CASI HC A04/MF A01

Planetary surface exploration micro-rovers for collecting data about the Moon and Mars was designed by the Department of Mechanical Engineering at the University of Idaho. The goal of both projects was to design a rover concept that best satisfied the project objectives for NASA-Ames. A second goal was to facilitate student learning about the process of design. The first micro-rover is a deployment mechanism for the Mars Environmental SURvey (MESUR) Alpha Particle/Proton/X-ray instruments (APX). The system is to be launched with the sixteen MESUR landers around the turn of the century. A Tubular Deployment System and a spiked-legged walker was developed to deploy the APX from the lander to the Martian surface. While on Mars the walker is designed to take the APX to rocks to obtain elemental composition data of the surface. The second micro-rover is an autonomous, roving vehicle to transport a sensor package over the surface of the moon. The vehicle must negotiate the lunar-terrain for a minimum of one year by surviving impacts and withstanding the environmental extremes. The rover is a reliable track-driven unit that operates regardless of orientation which NASA can use for future lunar exploratory missions. A detailed description of the designs, methods, and procedures which the University of Idaho design teams followed to arrive at the final designs are included.
Author

**N93-18114*#** Texas Univ., Austin.
**DESIGN OF A COMPLIANT WHEEL FOR A MINIATURE ROVER TO BE USED ON MARS Final Report**
Mark Carroll, Jess Johnson, and Jimmy Yong 1991 163 p Original contains color illustrations
(Contract NASw-4435)
(NASA-CR-192012; NAS 1.26:192012) Avail: CASI HC A08/MF A02; 4 functional color pages

The Jet Propulsion Laboratory has identified the need for a compliant wheel for a miniature martian rover vehicle. This wheel must meet requirements of minimum mass, linear radial deflection, and reliability in cryogenic conditions over a five year lifespan. Additionally, axial and tangential deflections must be no more than 10 percent of the radial value. The team designed a wheel by use of finite element and dimensionless parameter analysis. Due to the complex geometry of the wheel, a finite element model describing its behavior was constructed to investigate different wheel configurations. Axial and tangential deflections were greatly reduced but did not meet design criteria. A composite material was selected for its high strength, toughness, fatigue resistance, and damping characteristics.

The team chose a Kevlar fiber filled thermoplastic composite. This report is divided into four primary sections. First, the introduction section gives background information, defines the task, and discusses the scope and limitations of the project. Second, the alternative designs section introduces alternative design solutions, addresses advantages and disadvantages of each, and identifies the parameters used to determine the best design. Third, the design solution section introduces the methods used to evaluate the alternates, and gives a description of the design process used. Finally, the conclusion and recommendations section evaluates the wheel design, and offers recommendations pertaining to improvement of the design solution. Author

**N93-18152*#** Texas Univ., Austin. Dept. of Aerospace Engineering.
**THE SIMPSONS PROJECT: AN INTEGRATED MARS TRANSPORTATION SYSTEM Final Design Report**
Matthew Kaplan, Eric Carlson, Sherie Bradfute, Kent Allen, Francois Duvergne, Bert Hernandez, David Le, Quan Nguyen, and Brett Thornhill [1992] 194 p Sponsored in cooperation with USRA
(Contract NASw-4435)
(NASA-CR-192035; NAS 1.26:192035) Avail: CASI HC A09/MF A03

In response to the Request for Proposal (RFP) for an integrated transportation system network for an advanced Martian base, Frontier Transportation Systems (FTS) presents the results of the SIMPSONS project (Systems Integration for Mars Planetary Surface Operations Networks). The following topics are included: the project background, vehicle design, future work, conclusions, management status, and cost breakdown. The project focuses solely on the surface-to-surface transportation at an advanced Martian base. Author

**N93-18162*#** Florida Agricultural and Mechanical Univ., Tallahassee. College of Engineering.
**EXTENDED MISSION/LUNAR ROVER, EXECUTIVE SUMMARY Final Design Report, 1991 - 1992**
1992 25 p
(Contract NASw-4435)
(NASA-CR-192017; NAS 1.26:192017) Avail: CASI HC A03/MF A01

The design project selected to be undertaken by the 1991/92 Aerospace Design Group was that of conceptually designing an Extended Mission Rover for use on the Lunar Surface. This vehicle would serve the function as a mobile base of sorts, and be able to provide future astronauts with a mobile 'shirt-sleeve' self-sufficient living and working environment. Some of the proposed missions would be planetary surface exploration, construction and maintenance, hardware set-up and in-situ resource experimentation. The need for this type of vehicle has already been declared in the Stafford Group's report on the future of America's Space Program, entitled 'America at the Threshold: America's Space Exploration Initiative'. In the four architectures described within the report, the concept of a pressurized vehicle occurred multiple times. The approximate time frame that this vehicle would be put into use is 2010-2030. Author

**N93-18286*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**RETRACTABLE TOOL BIT HAVING LATCH TYPE CATCH MECHANISM Patent**
George Voellmer, inventor (to NASA) 19 Jan. 1993 7 p Filed 22 Nov. 1991 Supersedes N92-23378 (30 - 14, p 2381)
(NASA-Case-GSC-13359-1; US-Patent-5,180,259;
US-Patent-Appl-SN-796496; US-Patent-Class-408-124;
US-Patent-Class-279-23.1; US-Patent-Class-279-79;
US-Patent-Class-408-239R; US-Patent-Class-408-241R;
US-Patent-Class-901-41; Int-Patent-Class-B23B-31/10) Avail: US Patent and Trademark Office

A retractable tool bit assembly for a tool such as an allen key is presented. The assembly includes one or more spring loaded nestable or telescoping tubular sections together with a catch mechanism for capturing and holding the tool in its retracted position. The catch mechanism consists of a latch mechanism located in a base section and which engages a conically shaped tool head located at the inner end of the tool. The tool head adjoins an eccentric oval type neck portion which extends to a rear lip of the tool head. The latch mechanism releases when the ovular neck portion rotates about the catch members upon actuation of a rotary tool drive motor. When released, all the telescoping sections and the tool extends fully outward to a use position.
Official Gazette of the U.S. Patent and Trademark Office

**N93-18288*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**SPLIT RAIL GRIPPER ASSEMBLY AND TOOL DRIVER THEREFOR Patent**
George M. Voellmer, inventor (to NASA) 9 Feb. 1993 10 p Filed 2 Sep. 1992 Continuation-in-part of US-Patent-Appl-SN-656924, filed 15 Feb. 1991
(NASA-Case-GSC-13370-2; US-Patent-5,184,861;
US-Patent-Appl-SN-938577; US-Patent-Appl-SN-656924;
US-Patent-Class-294-119.1; US-Patent-Class-901-41;
US-Patent-Class-294-907; Int-Patent-Class-B25J-15/08) Avail: US Patent and Trademark Office

This patent relates to a split rail gripper for a robotic apparatus including a pair of rails which are driven in mutually opposite directions by a rack and pinion gear mechanism. Each rail includes a set of rack gear teeth which engage respective pinion gears and where the top rail engaging one of the pinion gears is driven by a harmonic gear reduction drive and motor unit coupled to a drive screw. The other pinion gear is driven by the top pinion gear engaging a set of rack gear teeth included in the bottom rail. As the top rail is driven in or out, the upper pinion gear is rotated, causing the other pinion gear, in turn, to rotate in the opposite direction. This causes the bottom rail to move in an opposite linear direction relative to the top rail. An outwardly extending gripper finger assembly is attached to respective ends of the rails, with each gripper finger including an arrangement of vertically and horizontally mounted roller members which operate to automatically center and engage an H-plate type interface secured to the object being grasped. The gripper assembly also includes a base plate attached to an interface plate of a robotic tool changer mechanism. A retractable rotary tool driver and tool is also centrally mounted on the base plate. Official Gazette of the U.S. Patent and Trademark Office

**N93-18321*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**BRUSH SEAL BRISTLE FLEXURE AND HARD-RUB CHARACTERISTICS**
Robert C. Hendricks, Julie A. Carlile, and Anita D. Liang Aug. 1992 23 p Presented at the Seals Workshop, Cleveland, OH, 5-6 Aug. 1992
(RTOP 590-21-11)
(NASA-TM-105864; E-7281; NAS 1.15:105864) Avail: CASI HC A03/MF A01

The bristles of a 38.1-mm (1.5-in) diameter brush seal were flexed by a tapered, 40-tooth rotor operating at 2600 rpm that provided sharp leading-edge impact of the bristles with hard rubbing of the rotor lands. Three separate tests were run with the same brush accumulating over 1.3 x 10(exp 9) flexure cycles while deteriorating 0.2 mm (0.008 in) radially. In each, the test bristle incursion depth varied from 0.130 to 0.025 mm (0.005 to 0.001 in) or less (start to stop), and in the third test the rotor was set 0.25 mm (0.010 in) eccentric. Runout varied from 0.025 to 0.076 mm (0.001 to 0.003 in) radially. The bristles wore but did not pull out, fracture, or fragment. Bristle and rotor wear debris were deposited as very fine, nearly amorphous, highly porous materials at the rotor groove leading edges and within the rotor grooves. The land leading edges showed irregular wear and the beginning of a convergent groove that exhibited sharp, detailed wear at the land trailing edges. Surface grooving, burnishing, 'whipping,' and hot spots and streaks were found. With a smooth-plug rotor post-test leakage increased 30 percent over pretest leakage. Author

**N93-18371*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**ACTIVELY CONTROLLED SHAFT SEALS FOR AEROSPACE APPLICATIONS Semiannual Status Report, Jan. - Jun. 1992**
Richard F. Salant 1992 22 p
(Grant NAG3-974)
(NASA-CR-191901; NAS 1.26:191901; E25-666) Avail: CASI HC A03/MF A01

The objective of years 4 and 5 of this project (1992 and 1993) is to determine experimentally the behavior and operating characteristics of a controllable mechanical seal, and to identify potential problem areas. A controllable mechanical seal is one in which the thickness of the lubricating

film separating the sealing surfaces is adjustable, and can be controlled by an electronic control system, based on information supplied by sensors that monitor the condition of the film. This work builds upon work done during years 1-3, in which a controllable mechanical seal was designed, analyzed, and fabricated. At the beginning of year 4, the mechanical seal and test rig was assembled, and preliminary testing begun. The five major tasks of years 4 and 5 encompass instrumentation, configuration changes of the mechanical seal to optimize its performance, systematic steady state tests, systematic transient tests, and a final report. During this reporting period, significant progress was made on instrumenting the test rig and modifying the design to optimize the seal's performance. Initial steady state tests were also performed. Author

**N93-18380*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**INTEGRITY TESTING OF BRUSH SEAL IN SHROUD RING OF T-700 ENGINE**

Robert C. Hendricks, Thomas A. Griffin, George B. Bobula, Robert C. Bill, and Harold W. Howe (Technetics, Inc., DeLand, FL.) Aug. 1992 25 p Presented at the Seals Workshop, Cleveland, OH, 5-6 Aug. 1992

(RTOP 590-21-11)

(NASA-TM-105863; E-7282; NAS 1.15:105863) Avail: CASI HC A03/MF A01

A split-ring brush seal was fabricated, installed between two labyrinth-honeycomb shroud seals, and tested in the fourth-stage turbine of a T-700 engine. The annealed Haynes 25 bristles rubbed directly against the nonconditioned, irregular Rene 80 turbine blade shroud surface. A total of 30 hr of cyclic and steady-state data were taken with surface speeds to 335 m/s (1100 ft/s) and shroud temperatures to 620 C (1150 F). Wear appeared to be rapid initially, with an orange flash of hot brush fragments during the first engine startup, to minimal after 10 hr of operation. The brush survived the testing but experienced some bristle pullouts and severe bristle wear; some turbine interface wear and possible material transfer was noted. Future design concerns center on tribological behavior at the interface with or without lubricants. Author

**N93-18531#** Massachusetts Energy Office, Boston. Div. of Resources.

**TRANSPORTATION ALTERNATIVES 92: ALTERNATIVE FUELED VEHICLES, VOLUME 2**

1992 111 p Presented at the Northeast Sustainable Energy Association Meeting, Boston, MA, 9-10 Oct. 1992

(DE93-001500; CONF-9210183-Vol-2) Avail: CASI HC A06/MF A02

Transportation Alternatives 92 (alternative fueled vehicles) was held October 8-9, 1992 at the Massachusetts Division of Energy Resources, Boston, MA. The relevant papers have been entered individually. DOE

**N93-18536#** Oak Ridge National Lab., TN.

**EVALUATION AND SILICON NITRIDE INTERNAL COMBUSTION ENGINE COMPONENTS**

W. Voldrich Apr. 1992 75 p Prepared in cooperation with Allied-Signal Aerospace Co., Torrance, CA

(Contract DE-AC05-84OR-21400)

(DE93-003628; ORNL/Sub-89-SE500/1) Avail: CASI HC A04/MF A01

The feasibility of silicon nitride (Si3N4) use in internal combustion engines was studied by testing three different components for wear resistance and lower reciprocating mass. The information obtained from these preliminary spin rig and engine tests indicates several design changes are necessary to survive high-stress engine applications. The three silicon nitride components tested were valve spring retainers, tappet rollers, and fuel pump push rod ends. Garrett Ceramic Components' gas-pressure sinterable Si3N4 (GS-44) was used to fabricate the above components. Components were final machined from densified blanks that had been green formed by isostatic pressing of GS-44 granules. Spin rig testing of the valve spring retainers indicated that these Si3N4 components could survive at high RPM levels (9,500) when teamed with silicon nitride valves and lower spring tension than standard titanium components. Silicon nitride tappet rollers showed no wear on roller O.D. or I.D. surfaces, steel axles and lifters; however, due to the uncrowned design of these particular rollers the cam lobes indicated wear after spin rig testing. Fuel pump push rod ends were successful at reducing wear on the cam lobe and rod end when tested on spin rigs and in real-world race applications. DOE

**N93-18632#** Technical Research Centre of Finland, Espoo. Production Engineering Lab.

**A NEW JOURNAL BEARING TESTER: THE VTT WATER TRIBOTESTER**

Peter Andersson Aug. 1992 26 p Sponsored by Technology Development Center of Finland; Helsinki Univ. of Technology; and Tampere Univ. of Technology

(VTT-TIED-1345; ISBN-951-38-4158-8; ETN-93-93067) Copyright Avail: CASI HC A03/MF A01

The design and operation of equipment for the testing of journal bearings is described. The equipment was developed and used for the first time in a Finnish project in ceramic journal bearings. Two similar units were built in two different laboratories, one for oil and the other for water lubrication. The VIT (Technical Research Center of Finland) tribotester was designed for wide flexibility in the selection of the normal force, speed and lubricant and to make rapid test piece exchanges possible. Furthermore, the machine was designed to be easy to build, use, maintain and understand. The journal bearing to be tested has an inner diameter of 40 mm and a width of 20 mm. Exchangeable shaft bushes are used as counterpieces in the tests. The tribotester is designed for normal loads of up to 40 kN, and rotational speeds of up to 5300 rpm can be allowed. During the tests, at least the frictional force and the bearing shell temperature are continuously recorded. The wear rates are determined after a test. The first test program consisted of 22 water lubricated tests, 16 of which were performed with specimens made of monolithic ceramics and 6 with steel specimens plasma coated with ceramics. The results of the journal bearing tests are in good agreement with previous 'pin on disc' model tests. In the majority of the tests the equipment behaved as planned, and new investigations will follow. ESA

**N93-18658#** EG and G Energy Measurements, Inc., Idaho Falls.

**SENSING THE GAS METAL ARC WELDING PROCESS**

N. M. Carlson, J. A. Johnson, H. B. Smartt, A. D. Watkins, E. D. Larsen, P. L. Taylor, and M. A. Waddoups (Idaho National Engineering Lab., Idaho Falls.) 1992 20 p Presented at the International Conference on Computerization of Welding, Orlando, FL, 3-6 Nov. 1992

(Contract DE-AC07-76ID-01570)

(DE93-001957; EGG-M-92101; CONF-9211113-1) Avail: CASI HC A03/MF A01

Control of gas metal arc welding (GMAW) requires real-time sensing of the process. Three sensing techniques for GMAW are being developed at the Idaho National Engineering Laboratory (INEL). These are as follows: (1) noncontacting ultrasonic sensing using a laser/EMAT (electromagnetic acoustic transducer) to detect defects in the solidified weld on a pass-bypass basis; (2) integrated optical sensing using a CCD camera and a laser stripe to obtain cooling rate and weld bead geometry information; and (3) monitoring fluctuations in digitized welding voltage data to detect the mode of metal droplet transfer and assure that the desired mass input is achieved. DOE

**N93-18695#** Technical Research Centre of Finland, Espoo. Metals Lab.

**CALCULATION OF THE FATIGUE LIFE OF A SURFACE-HARDENED SHAFT BY THE FINITE-ELEMENT METHOD**

Heikki Keinaenen and Klaus Rahka Mar. 1992 26 p Sponsored by Technology Development Center of Finland; and Ovako Co.; and Valmet Corp. Original contains color illustrations

(VTT-Pubs-92; ISBN-951-38-4070-0; ISSN-1235-0621; ETN-93-93070)

Copyright Avail: CASI HC A03/MF A01; 3 functional color pages

The problems encountered in machine component design are discussed. These problems arise when the material properties vary in the load carrying cross section and when purely elastic design is unsuitable, that is, when fatigue may be an imminent failure mechanism. Solution procedures are carried out by an elastoplastic finite element calculation for the surface hardened cylindrical shaft in bending, torsion and combined bending torsion. The effective plastic strains in the cross section of the shaft are calculated and the fatigue life of the shaft is predicted according to the local strain approach. The analyzed shaft is surface hardened by induction heating, the hardness and other material properties thus varying between the core and the surface. The loading is bending or torsion. Only the monotonic first quarter cycle of the loading is calculated. The fatigue life is evaluated using the calculated effective plastic strain amplitude. ESA

**N93-18778*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.

**CONTROLLED MOTION IN AN ELASTIC WORLD. RESEARCH PROJECT: MANIPULATION STRATEGIES FOR MASSIVE SPACE PAYLOADS Final Report, 15 Nov. 1989 - 15 Dec. 1992**

Wayne J. Book 15 Dec. 1992 48 p Submitted for publication

(Grant NAG1-623)

(NASA-CR-191895; NAS 1.26:191895; E25-517) Avail: CASI HC A03/MF A01

The flexibility of the drives and structures of controlled motion systems are presented as an obstacle to be overcome in the design of high performance motion systems, particularly manipulator arms. The task and the measure of performance to be applied determine the technology appropriate to overcome this obstacle. Included in the technologies proposed are control algorithms (feedback and feed forward), passive damping enhancement, operational strategies, and structural design. Modeling of the distributed, nonlinear system is difficult, and alternative approaches are discussed. The author presents personal perspectives on the history, status, and future directions in this area. Author

**N93-18851*#** Alabama Univ., Huntsville. Electrical and Computer Engineering Dept.

**ROBOT WELDING PROCESS CONTROL DEVELOPMENT TASK Final Report, 9 May 1991 - 8 May 1992**

Peter L. Romine Dec. 1992 34 p

(Contract NAS8-36955)

(NASA-CR-192434; NAS 1.26:192434) Avail: CASI HC A03/MF A01

The completion of, and improvements made to, the software developed during 1990 for program maintenance on the PC and HEURIKON and transfer to the CYRO, and integration of the Rocketdyne vision software with the CYRO is documented. The new programs were used successfully by NASA, Rocketdyne, and UAH technicians and engineers to create, modify, upload, download, and control CYRO NC programs. Author

**N93-18862*#** Massachusetts Inst. of Tech., Cambridge. Gas Turbine Lab.

**ACTIVE STABILIZATION TO PREVENT SURGE IN CENTRIFUGAL COMPRESSION SYSTEMS Final Technical Report, 1 Dec. 1986 - 29 Feb. 1992**

Alan H. Epstein, Edward M. Greitzer, Jon S. Simon, and Lena Valavani Jan. 1993 248 p

(Grant NAG3-770)

(NASA-CR-191625; NAS 1.26:191625) Avail: CASI HC A11/MF A03

This report documents an experimental and analytical study of the active stabilization of surge in a centrifugal engine. The aims of the research were to extend the operating range of a compressor as far as possible and to establish the theoretical framework for the active stabilization of surge from both an aerodynamic stability and a control theoretic perspective. In particular, much attention was paid to understanding the physical limitations of active stabilization and how they are influenced by control system design parameters. Previously developed linear models of actively stabilized compressors were extended to include such nonlinear phenomena as bounded actuation, bandwidth limits, and robustness criteria. This model was then used to systematically quantify the influence of sensor-actuator selection on system performance. Five different actuation schemes were considered along with four different sensors. Sensor-actuator choice was shown to have a profound effect on the performance of the stabilized compressor. The optimum choice was not unique, but rather shown to be a strong function of some of the non-dimensional parameters which characterize the compression system dynamics. Specifically, the utility of the concepts were shown to depend on the system compliance to inertia ratio ('B' parameter) and the local slope of the compressor speedline. In general, the most effective arrangements are ones in which the actuator is most closely coupled to the compressor, such as a close-coupled bleed valve inlet jet, rather than elsewhere in the flow train, such as a fuel flow modulator. The analytical model was used to explore the influence of control system bandwidth on control effectiveness. The relevant reference frequency was shown to be the compression system's Helmholtz frequency rather than the surge frequency. The analysis shows that control bandwidths of three to ten times the Helmholtz frequency are required for larger increases in the compressor flow range. This has important implications for implementation in gas turbine engines since the Helmholtz frequencies can be over 100 Hz, making actuator design extremely challenging. Author

**N93-18961#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**POWER ANALYSIS IN FLEXIBLE AUTOMATION M.S. Thesis**

Nathan A. Titus 15 Dec. 1992 98 p

(AD-A259080; AFIT/GA/ENG/92D-12) Avail: CASI HC A05/MF A02

The performance of an automation or robotic device can be measured in terms of its power efficiency. Screw theory is used to mathematically define the task instantaneously with two screws. The task wrench defines the effect of the device on its environment, and the task twist describes the motion of the device. The tasks can be separated into three task types: kinetic, manipulative, and reactive. Efficiency metrics are developed for each task type. The output power is strictly a function of the task screws, while device input power is shown to be a function of the task, the device Jacobian, and the actuator type. Expressions for input power are developed for two common types of actuators, DC servometers and hydraulic actuators. Simple examples are used to illustrate how power analysis can be used for task/workspace planning, actuator selection, device configuration design, and redundancy resolution. GRA

**N93-19027*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**HIGH-TEMPERATURE, BELLOWS HYBRID SEAL Patent Application**

B. M. Steinetz, inventor (to NASA) and P. J. Sirocky, inventor (to NASA) (Sverdrup Technology, Inc., Brook Park, OH.) 22 Jan. 1993 15 p

(NASA-Case-LEW-15570-1; NAS 1.71:LEW-15570-1;

US-Patent-Appl-SN-007874) Avail: CASI HC A03/MF A01

A high-temperature hybrid seal is constructed of multiple elements to meet the many demands placed on the seal. The primary elements are: a central high-temperature bellows, a braided ceramic sheath covering the bellows, an outer abrasion resistant sheath covering the ceramic sheath, and a structurally-sound seal-end termination. NASA

**N93-19033** Connecticut Univ., Storrs.

**COMPUTATIONAL KINEMATICS OF MULTI-ARM MANIPULATORS Ph.D. Thesis**

Siamak Vahidi 1992 230 p

Avail: Univ. Microfilms Order No. DA9300957

Kinematics of multi-arm/multi-loop manipulator systems entail highly nonlinear and coupled systems of equations. This thesis studies and offers methods for topology and kinematic analysis of these systems. In particular, computational complexities, which has so far prevented the development of robust and reliable routines for such analysis, are studied and efficient remedies and solutions developed. Following are the steps taken towards development of these solutions: a new description for the topology of the multi-arm manipulator system resulting in an expression containing information about structure of individual arms; formulation of a unique Jacobian sub-matrix containing differential relations between joint rates and end effectors' velocities of the entire system irrespective of the topology; a new definition for performance evaluation of the manipulator system based on displacement of an entire body from one point to another; a new description for equations of motion based on Euler angles and their derivatives resulting in an exact solution for evaluation of deviation of end effectors between current and goal locations; and significant modifications for removing the manipulator system from a near-singular or hard to reach position. Dissert. Abstr.

**N93-19044** Kansas Univ., Lawrence.

**VOICE CONTROL OF A DUAL-ARM TELEROBOT Ph.D. Thesis**

Robert Arthur Haberlein 1991 276 p

Avail: Univ. Microfilms Order No. DA9238647

This investigation explores voice control of a dual-arm telerobot. A literature review of voice control, voice technology and work measurements is conducted. This review includes a discussion of important voice technology topics, a survey of commercial voice equipment, and a study of industrial and vocational work measurement techniques. A voice control system is created for two Kraft GRIPS Master-Slave telerobotic manipulators. This system is based upon the concept of distributed computer control using inexpensive PC-AT computers that exchange information according to special

communication and command protocols. The voice control system consists of four separate sub-systems; a Camera Sub-system that controls a motorized camera mount, a Teach Pendant Sub-system that emulates two standard Termiflex teach pendants, a Switch Sub-system that controls the Kraft Master switches, and a Voice Sub-system that accepts the operator's vocal commands and broadcasts digitally-recorded messages. The Voice Sub-system utilizes a Votan VPC-2100 recognition board and a TI-Speech synthesis board. The vocal commands are organized into a hierarchical structure based upon the fire-and-forget control scheme. A visual display of the vocal command status is also detailed. In order to measure the effect of the voice control system upon the work performance of the telerobot, a formal experimental plan is described using twenty-four untrained operators divided into a voice group and a control group. Each group performs an experimental taskset using modified peg-in-hole vocational rehabilitation assessment test equipment. The experimental taskset consists of eight separate subtasks that exercise each of the four voice control sub-systems. The times to complete the subtasks are recorded to score each group's work performance. A split-plot ANOVA of the performance scores reveals significant group improvements in both the mean performance and the performance variance for those tasks which involve control of the telerobot and its peripheral systems. No significant group differences are found for those subtasks which chiefly involve the dexterity of the telerobotic Slaves. Dissert. Abstr.

**N93-19049*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**VALVE LOCK Patent Application**

Richard K. Burley, inventor (to NASA) (Rockwell International Corp., Huntsville, AL.) and Kamal S. Guirguis, inventor (to NASA) (Rockwell International Corp., Huntsville, AL.) 17 Nov. 1992 11 p

(NASA-Case-MFS-29764-1; NAS 1.71:MFS-29764-1;
US-Patent-Appl-SN-977469) Avail: CASI HC A03/MF A01

A valve security lock is provided which secures a double union ball valve. The lock is formed from a band inserted through slits in a tube, with that combination being positioned over the valve stem to be secured, and the ends of the band wrapped around the circumference of the double union ball valve. The apparatus is secured around the double union ball valve by insertion of the shank of a lock of known kind through holes in the ends of the band. In a fluid control system, the valve security lock provides a highly visible means to prevent accidental turn-ons or turn-offs during system maintenance, but which can be easily disengaged by persons having the key or combination to the shank type lock. NASA

**N93-19057** Missouri Univ., Rolla.

**ROBUST CONTROL OF SMART STRUCTURES Ph.D. Thesis**

Seung-Woo Rhee 1992 133 p

Avail: Univ. Microfilms Order No. DA9239693

The use of the shape memory alloy Nitinol wire is investigated as an actuator for enhancing the damping in structural vibration systems. Classical control and robust control laws for the single-input/single-output case are designed and implemented for a simple cantilever beam. Nitinol wire and a strain gage are used as the actuator and sensor, respectively. A finite element model of the beam is formulated and compared with experimental results. The numerical simulation of several closed-loop control systems is also determined in terms of a response to an initial-condition input and compared with the experimental results of real-time control. The time response of the closed-loop system demonstrates the excellent capability of Nitinol wire to damp out free structural vibration. To demonstrate the capability of Nitinol wire with a robust controller for the multi-input/multi-output case, a three-mass structural system is designed and built. A finite element model is formulated and is verified experimentally. Strain gages are used as sensors for the three-mass system. Local strain information is used as a measured output and a state-variable model is formulated using the finite element model of the three-mass system. After the actuator dynamics is included into the system model, a robust controller is designed for a two-input/two-output case using the commercial software package MATRIXx. A numerical simulation is performed. Using a 386-based personal computer, a robust control algorithm is implemented. Significantly damped time responses of the closed-loop system are obtained experimentally, and compared with the open-loop response for the fundamental and second modes of vibration. Dissert. Abstr.

**N93-19059** Carnegie-Mellon Univ., Pittsburgh, PA.

**A MICROMECHANICAL FASTENING SYSTEM AND ITS APPLICATIONS Ph.D. Thesis**

Hongtao Han 1992 117 p

Avail: Univ. Microfilms Order No. DA9238809

We have developed two types of microstructures for mechanical fastening using micromachining technology. Mating structures, referred to as micro-velcro, are fabricated on standard silicon wafers, with an areal density of approximately 200,000 per sq cm. The individual component is 16 microns wide and 12 microns high. Piercing microstructures, referred to as micro barbs, have the same areal density as the micro-velcro, and fabricated in a similar way except a highly undercutting anisotropic etch was utilized. A single unit of the micro barbs is about 4 microns wide and 4 microns high. The micro-velcro will interlock with its mating structures upon applying a sufficient external force. The bonding principle is analogous to zippers, railcar couplings, and button snaps. Experimental tests not only confirm that the mechanical latching occurred, but also show a strong bonding of about 1.1 MPa, or 160 psi, per unit interlocked area. In order to investigate the bonding potential, we developed a cantilever beam model to analyze the distributions of bending stress, shearing stress and bending moment during separation of latched micro-velcro. The relative importance of various structural failure mechanisms have been evaluated, and experimental tests have confirmed the validity of these calculations. We have also estimated the bonding strength of the interlocked microstructures, and the equivalent surface energy representing the stored strain energy of the stressed microstructures. The bonding strength estimated by the theoretical approximation is in agreement with the upper end of our experimentally determined values. Optimization of the design of this micromechanical adhesive system indicates a bonding strength as high as 17 MPa could be achieved. In contrast to micro-velcro, the micro barbs will pierce through biologic tissues and latch. We conducted functional tests by pressing the samples fabricated with micro barbs into sections of a human vena cava obtained from a cadaver. The samples were successfully bonded to the tissue, but the tensile strength was below that required for clinical application. We found the size of micro barbs needs to be enlarged due to the delamination of tissues in testing. A project toward large scale micro barbs is underway. Dissert. Abstr.

**N93-19079#** Systran Corp., Dayton, OH.

**MECHANICAL BEHAVIOR OF TITANIUM ALUMINIDE UNDER ENGINE OPERATING CONDITIONS Final Report, 1 Jul. 1988 - 30 Sep. 1990**

N. Jayaraman Aug. 1992 129 p

(Contract F33615-88-C-5408)

(AD-A258884; WL-TR-91-4079) Avail: CASI HC A07/MF A02

A brief study to optimize the heat treatment for a useful balance of mechanical properties in Ti-25 percent Al-10 percent Nb-3 percent V-1 percent Mo (atomic percent) was conducted. The selected heat treatment consisted of solution treatment at 1115 C (in the alpha + beta field, about 25 C below the transus temperature) in vacuum for 1 hour followed by cooling to room temperature in argon, followed by aging at 760 C in vacuum for 8 hours, followed by cooling at room temperature in argon. This treatment resulted in fine transformed microstructure with high (25 percent) volume fraction of primary alpha2-phase. This treatment resulted in superior fatigue crack growth resistance while still maintaining good tensile and creep properties. This solution and age heat treatment was used for study of the effects of several factors such as temperature (25, 425, 540, and 650 C), environment (air and ultrahigh vacuum), frequency (0.01 to 1 Hz), R-ratio (0.1 and 0.8), and orientation (parallel and perpendicular to the final rolling direction) on the fatigue crack growth behavior. GRA

**N93-19331*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**COOLED SPOOL PISTON COMPRESSOR Patent Application**

B. G. Morris, inventor (to NASA) 29 Dec. 1992 20 p

(NASA-Case-MSC-22020-1; NAS 1.71:MSC-22020-1;
US-Patent-Appl-SN-998062) Avail: CASI HC A03/MF A01

A hydraulically powered gas compressor receives low pressure gas and outputs a high pressure gas. The housing of the compressor defines a cylinder with a center chamber having a cross-sectional area less than the cross-sectional area of a left end chamber and a right end chamber, and a spool-type piston assembly is movable within the cylinder and includes

a left end closure, a right end closure, and a center body that are in sealing engagement with the respective cylinder walls as the piston reciprocates. First and second annual compression chambers are provided between the piston enclosures and center housing portion of the compressor, thereby minimizing the spacing between the core gas and a cooled surface of the compressor. Restricted flow passageways are provided in the piston closure members and a path is provided in the central body of the piston assembly, such that hydraulic fluid flows through the piston assembly to cool the piston assembly during its operation. The compressor of the present invention may be easily adapted for a particular application, and is capable of generating high gas pressures while maintaining both the compressed gas and the compressor components within acceptable temperature limits. NASA

**N93-19378*#** Wisconsin Univ., Madison. The Applied Superconductivity Center.

**STUDY OF MAGNETIC BEARINGS WITH HIGH TEMPERATURE SUPERCONDUCTORS, PHASE 3**

Y. M. Eyssa and X. Huang Dec. 1991 17 p

(Grant NAG3-1041)

(NASA-CR-192229; NAS 1.26:192229) Avail: CASI HC A03/MF A01

Three areas related to the actively controlled radial magnetic bearing concepts are discussed. These areas are: (1) modification to the ac loss calculations of the 1990 report; (2) a continuous changing mechanism to compensate rotor current drop due to ac losses; and (3) design of a proof of principle experiment simulating the proposed bearing concept. Author

**N93-19478#** Sandia National Labs., Albuquerque, NM.

**COOPERATION OF MOBILE ROBOTS FOR ACCIDENT SCENE INSPECTION**

R. H. Byrne and J. Harrington 1992 7 p Presented at the ISRAM 1992: 4th International Symposium on Robotics and Manufacturing, Sante Fe, NM, 11-13 Nov. 1992

(Contract DE-AC04-76DP-00789)

(DE93-002487; SAND-92-1722C; CONF-921181-4) Avail: CASI HC A02/MF A01

A telerobotic system demonstration was developed for the Department of Energy's Accident Response group to highlight the applications of telerobotic vehicles to accident site inspection. The proof-of-principle system employs two mobile robots, Dixie and RAYBOT, to inspect a simulated accident site. Both robots are controlled serially from a single driving station, allowing an operator to take advantage of having multiple robots at the scene. The telerobotic system is described and some of the advantages of having more than one robot present are discussed. Future plans for the system are also presented. DOE

**N93-19832#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**TUBE DIODE [ELETROVALVULA BIESTAVEL]**

Evaldo Jose Corat, Vladimir Jesus Trava Airoldi, and Jose Nivaldo Hinckel Nov. 1991 34 p In PORTUGESE

(INPE-5438-NTC/304) Avail: CASI HC A03/MF A01

In this report we present the calculations, design, fabrication procedures and test results for a latch valve, under development for the MECB remote sensing satellites. The valve was made entirely with materials and processes available in the brazilian market. A valve considering the utilization of Sa-Co magneti, not available in the brazilian market was also designed. Author

**N93-19837#** Society of Automotive Engineers, Inc., Warrendale, PA.

**ELECTRIC AND HYBRID VEHICLE TECHNOLOGY: TOPTEC**

1992 285 p Presented at the Electric and Hybrid Vehicle Technology TOPTEC Workshop, Dearborn, MI, 14-15 Sep. 1992

(Contract DE-FG02-92CH-10504)

(DE93-002810; CONF-9209256) Avail: CASI HC A13/MF A03

Today, growing awareness of environmental and energy issues associated with the automobile has resulted in renewed interest in the electric vehicle. In recognition of this, the Society of Automotive Engineers has added a TOPTEC on electric vehicles to the series of technical symposia focused on key issues currently facing industry and government. This workshop on the Electric and Hybrid Vehicle provides an opportunity to learn about recent progress in these rapidly changing technologies. Research and development of both the vehicle and battery system has accelerated sharply and in fact, the improved technologies of the powertrain system make the performance of today's electric vehicle quite comparable to the equivalent gasoline vehicle, with the exception of driving range between 'refueling' stops. Also, since there is no tailpipe emission, the electric vehicle meets the definition of 'Zero Emission Vehicle: embodied in recent air quality regulations. The discussion forum will include a review of the advantages and limitations of electric vehicles, where the technologies are today and where they need to be in order to get to production level vehicles, and the service and maintenance requirements once they get to the road. There will be a major focus on the status of battery technologies, the various approaches to recharge of the battery systems and the activities currently underway for developing standards throughout the vehicle and infrastructure system. Intermingled in all of this technology discussion will be a view of the new relationships emerging between the auto industry, the utilities, and government. Since the electric vehicle and its support system will be the most radical change ever introduced into the private vehicle sector of the transportation system, success in the market requires an understanding of the role of all of the partners, as well as the new technologies involved. DOE

**N93-19946*#** Alabama Univ., Tuscaloosa. Dept. of Mechanical Engineering.

**DESIGN AND APPLICATION OF ELECTROMECHANICAL ACTUATORS FOR DEEP SPACE MISSIONS Semiannual Progress Report, 16 Aug. 1992 - 15 Feb. 1993**

Tim A. Haskew and John Wander 15 Feb. 1993 44 p

(Grant NAG8-240)

(NASA-CR-192227; NAS 1.26:192227) Avail: CASI HC A03/MF A01

During the period 8/16/92 through 2/15/93, work has been focused on three major topics: (1) screw modeling and testing; (2) motor selection; and (3) health monitoring and fault diagnosis. Detailed theoretical analysis has been performed to specify a full dynamic model for the roller screw. A test stand has been designed for model parameter estimation and screw testing. In addition, the test stand is expected to be used to perform a study on transverse screw loading. Derived from text

**N93-18839*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**EVALUATION OF INERTIAL DEVICES FOR THE CONTROL OF LARGE, FLEXIBLE, SPACE-BASED TELEROBOTIC ARMS**

Raymond C. Montgomery, Sean P. Kenny, Dave Ghosh (Lockheed Engineering and Sciences Co., Hampton, VA.), and Joram Shenhar (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 289-301 (For primary document see N93-18818 06-18)

Avail: CASI HC A03/MF A04

**N93-18916*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**MATHEMATICAL MODELING OF BENT-AXIS HYDRAULIC PISTON MOTORS**

R. D. Bartos *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 224-235 (For primary document see N93-18897 06-32)

(RTOP 314-30-42-10-87)

Avail: CASI HC A03/MF A03

**N93-18917*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**REDUCING THE NET TORQUE AND FLOW RIPPLE EFFECTS OF MULTIPLE HYDRAULIC PISTON MOTOR DRIVES**

R. D. Bartos *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 236-245 (For primary document see N93-18897 06-32)

(RTOP 314-30-42-10-87)

Avail: CASI HC A02/MF A03

**N93-18929*#** Martin Marietta Corp., Denver, CO. Robotics and Advanced Controls Section.

**CSI RELATED DYNAMICS AND CONTROL ISSUES IN SPACE ROBOTICS**

Eric Schmitz and Madison Ramey *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology

Conference, Part 2 Feb. 1993 p 415-433 (For primary document see N93-18928 06-18)
Avail: CASI HC A03/MF A03

**N93-19393*#** University of Central Florida, Orlando. Dept. of Electrical Engineering.
**KINEMATIC ANALYSIS OF THE ARID MANIPULATOR**
Keith L Doty *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 69-80 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

**N93-19394*#** University of Central Florida, Orlando. Dept. of Electrical Engineering.
**CALIBRATION OF THE ARID ROBOT**
Keith L Doty *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 81-113 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

**N93-19395*#** University of Central Florida, Orlando. Dept. of Electrical Engineering.
**ARID RELATIVE CALIBRATION EXPERIMENTAL DATA AND ANALYSIS**
Keith L Doty *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 115-142 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

**N93-19398*#** Oklahoma State Univ., Stillwater. Dept. of Electrical and Computer Engineering.
**REDUNDANT DRIVE CURRENT IMBALANCE PROBLEM OF THE AUTOMATIC RADIATOR INSPECTION DEVICE (ARID)**
Carl D. Latino *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 199-228 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A05

**N93-19462*#** North Carolina Agricultural and Technical State Univ., Greensboro.
**NONLINEAR ROBUST CONTROLLER DESIGN FOR MULTI-ROBOT SYSTEMS WITH UNKNOWN PAYLOADS**
Y. D. Song, J. N. Anderson (Tennessee Technological Univ., Cookeville.), A. Homaifar, and H. Y. Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 16 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

**N93-19463*#** North Carolina Agricultural and Technical State Univ., Greensboro.
**ROBUST MOTION TRACKING CONTROL OF ROBOTIC ARMS BASED ON THE GENERALIZED ENERGY ACCUMULATION PRINCIPLE**
Y. D. Song, J. N. Anderson (Tennessee Technological Univ., Cookeville.), A. Homaifar, and H. Y. Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 8 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

## 38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

**N93-17856*#** Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
**SYSTEM FOR ANOMALY AND FAILURE DETECTION (SAFD) SYSTEM DEVELOPMENT Final Report**
D. OReilly 24 Jul. 1992 41 p
(Contract NAS8-40000)
(NASA-CR-184475; NAS 1.26:184475) Avail: CASI HC A03/MF A01

This task specified developing the hardware and software necessary to implement the System for Anomaly and Failure Detection (SAFD) algorithm, developed under Technology Test Bed (TTB) Task 21, on the TTB engine stand. This effort involved building two units; one unit to be installed in the Block II Space Shuttle Main Engine (SSME) Hardware Simulation Lab (HSL) at Marshall Space Flight Center (MSFC), and one unit to be installed at the TTB engine stand. Rocketdyne personnel from the HSL performed the task. The SAFD algorithm was developed as an improvement over the current redline system used in the Space Shuttle Main Engine Controller (SSMEC). Simulation tests and execution against previous hot fire tests demonstrated that the SAFD algorithm can detect engine failure as much as tens of seconds before the redline system recognized the failure. Although the current algorithm only operates during steady state conditions (engine not throttling), work is underway to expand the algorithm to work during transient condition. Author

**N93-18026#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**RELIABILITY, MAINTAINABILITY, AND SUPPORTABILITY (RMS) EDUCATION IN ENGINEERING SCHOOLS M.S. Thesis**
Gregory T. Hurst and Barry N. Kinter Dec. 1992 125 p
(AD-A258260; AFIT/GIR/LSQ/92D-6) Avail: CASI HC A06/MF A02

The purpose of this research is to show how engineering schools, as a whole, perceive the role of reliability, maintainability, and supportability in the engineering field. This includes the degree to which these concepts are included in their curricula, whether industry recruiters look for reliability, maintainability, and supportability training when they visit college campuses and to what degree college faculties are teaching reliability, maintainability, and supportability. This is done through research of existing literature and the analysis of data from a survey completed by engineering schools. General analyses are presented of the overall responses and detailed analysis of contrasts and similarities between the responses from private and public institutions are presented. Based upon the knowledge gained in conducting this research, conclusions on the state of RMS education in engineering institutions are forwarded. GRA

**N93-18097#** Technische Univ., Berlin (Germany). Inst. fuer Luft- und Raumfahrt.
**DEFECT TOLERANCE OF HYBRID PRESSURE VESSELS: THE TOTAL RELIABILITY VERSUS TOTAL FAILURE AS AN INTERPRETATION CRITERION [SCHADENSTOLERANTE HYBRID-DRUCKBEHAELTER: DIE GESAMTZUVERLAESSIGKEIT GEGEN TOTALAUSFALL ALS AUSLEGUNGSKRITERIUM]**
Georg W. Mair 1992 90 p In GERMAN
(ILR-Mitt-272(1992); ETN-93-93026) Avail: CASI HC A05/MF A01

The possibilities of weight reduction of high pressure vessels by a redundant interpretation by means of a fiber reinforcement are investigated with consideration of fail safe properties. The normal distribution of extreme reliabilities was calculated as a function of the Weibull distribution on the lateral sides. A computation model which describes the propagation direction of a metal crack with a probabilistic formulation was developed: the probability of a peripheral or longitudinal failure was given as a function of stiffness and a variation coefficient of the charge ratio sensitivity. Weight savings of 40 percent were realized with a probabilistically optimized 34CrMo4v-aramide fiber hybrid cylinder with consideration of choice of parameters such as protection against fiber damaging, load cycling, and strength. ESA

**N93-18253#** Maryland Univ., Baltimore.
**PARADIGM SHIFT: CAN TQM SAVE DOD'S PROCUREMENT PROCESS?**
Ross V. Romeo 25 Nov. 1992 43 p
(AD-A258319) Avail: CASI HC A03/MF A01

The Department of Defense's (DOD) ambitious introduction of total quality management (TQM) will fail, unless they change their paradigm and reengineer how they do business. TQM implementation in the defense department and possibilities for reengineering DOD's management structure were investigated. This paper uses a case study to investigate DOD's procurement efficiency and effectiveness with information technology. The findings show DOD is faced with its greatest challenge since WWII in meeting the rapidly evolving environment of the 1990s and the 21st century. GRA

**N93-18422*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SELF-GROWING NEURAL NETWORK ARCHITECTURE USING CRISP AND FUZZY ENTROPY**
Krzysztof J. Cios 24 Apr. 1992 17 p Presented at the International Conference on Aerospace Sensing, Orlando, FL, 20-24 Apr. 1992; sponsored by the Society of Photo-Optical Instrumentation Engineers
(RTOP 510-01-50)
(NASA-TM-105677; E-7052; NAS 1.15:105677) Avail: CASI HC A03/MF A01

The paper briefly describes the self-growing neural network algorithm, CID2, which makes decision trees equivalent to hidden layers of a neural network. The algorithm generates a feedforward architecture using crisp and fuzzy entropy measures. The results of a real-life recognition problem of distinguishing defects in a glass ribbon and of a benchmark problem of differentiating two spirals are shown and discussed. Author

**N93-18956#** Drexel Univ., Philadelphia, PA. Dept. of Electrical and Computer Engineering.
**NONDESTRUCTIVE EVALUATION OF GRAIN SIZE DISTRIBUTIONS USING MULTIFRACTAL ANALYSIS OF BACKSCATTERED ULTRASONIC SIGNALS Final Report, 15 Jul. 1989 - 14 Oct. 1992**
N. Bilgutay, B. Onaral, and D. Nicoletti 10 Dec. 1992 47 p
(Contract N00014-89-J-3106)
(AD-A259035) Avail: CASI HC A03/MF A01

Grain size is one of the factors which influence mechanical properties of metals like strength and fracture toughness. Ultrasonic waves propagating in polycrystalline materials are subject to attenuation dominated by grain boundary scattering. The importance of grain size estimation for industrial applications warrants the investigation of alternative methods of nondestructive grain size determination. Analysis of the power-law behavior of ultrasonic attenuation experimental data is used to link the wavelength dependence of the attenuation coefficient directly to the grain size distribution. The outcome is a simple relationship between the power-law which describes the grain size distribution and the power-law dependence of attenuation on wavelength. Justifications for the use of the power-law for the grain size distribution include scaling and self-similarity. Careful attention is given to the limitations in terms of a practical grain size distribution with finite limits. Two types of measurements are presented to verify the theoretical development: grain size distribution and ultrasonic attenuation. Nickel samples were prepared using three different annealing durations. The attenuation exponent is experimentally shown to be an appropriate nondestructive measurement of the grain size distribution exponent. Further scaling properties for different annealing durations are also explored. A nondestructive evaluation procedure is suggested for metal samples with identical grain size distribution exponents, where the shifts of the log-log representations of the attenuation curves can be used to characterize the different grain size distributions. GRA

**N93-19438#** Midwest Research Inst., Golden, CO.
**MEASUREMENT UNCERTAINTY ANALYSIS TECHNIQUES APPLIED TO PV PERFORMANCE MEASUREMENTS**
C. Wells Oct. 1992 20 p Presented at the Photovoltaics Performance and Reliability Workshop, Golden, CO, 16-18 Sep. 1992
(Contract DE-AC02-83CH-10093)
(DE93-000019; NREL/TP-411-5125; CONF-9209252-1) Avail: CASI HC A03/MF A01

The purpose of this presentation is to provide a brief introduction to measurement uncertainty analysis, outline how it is done, and illustrate uncertainty analysis with examples drawn from the PV field, with particular emphasis toward its use in PV performance measurements. The uncertainty information we know and state concerning a PV performance measurement or a module test result determines, to a significant extent, the value and quality of that result. What is measurement uncertainty analysis? It is an outgrowth of what has commonly been called error analysis. But uncertainty analysis, a more recent development, gives greater insight into measurement processes and tests, experiments, or calibration results. Uncertainty analysis gives us an estimate of the interval about a measured value or an experiment's final result within which we believe the true value of that quantity will lie. Why should we take the time to perform an uncertainty analysis? A rigorous measurement uncertainty analysis: Increases the credibility and value of research results; allows comparisons of results from different labs; helps improve experiment design and identifies where changes are needed to achieve stated objectives (through use of the pre-test analysis); plays a significant role in validating measurements and experimental results, and in demonstrating (through the post-test analysis) that valid data have been acquired; reduces the risk of making erroneous decisions; demonstrates quality assurance and quality control measures have been accomplished; define Valid Data as data having known and documented paths of: Origin, including theory; measurements; traceability to measurement standards; computations; uncertainty analysis of results. DOE

**N93-19753#** EG and G Mound Applied Technologies, Miamisburg, OH.
**MEASUREMENT PROCESS ERROR DETERMINATION AND CONTROL**
J. Everhart 1992 5 p Presented at the Productivity Quality Conference, Dayton, OH, 21-23 Oct. 1992
(Contract DE-AC04-88DP-43495)
(DE93-002948; MLM-3766; CONF-9210218-1) Avail: CASI HC A01/MF A01

Traditional production processes have required repeated inspection activities to assure product quality. A typical production process follows this pattern: production makes product; production inspects product; Quality Control (QC) inspects product to ensure production inspected properly QC then inspects the product on a different gage to ensure the production gage performance; and QC often inspects on a different day to determine environmental effect. All of these costly inspection activities are due to the lack of confidence in the initial production measurement. The Process Measurement Assurance Program (PMAP) is a method of determining and controlling measurement error in design, development, and production. It is a preventive rather than an appraisal method that determines, improves, and controls the error in the measurement process, including measurement equipment, environment, procedure, and personnel. PMAP expands the concept of the Measurement Assurance Program developed in the 1960's by the National Bureau of Standards (NBS), today known as the National Institute of Standards and Technology (NIST). PMAP acts as a bridge in the gap between the Metrology Laboratory and the production environment by introducing standards (or certified parts) into the production process. These certified control standards are then measured as part of the production process. A control system is present to examine the measurement results of the control standards before, during, and after the manufacturing and measuring of the product. The results of the PMAP control charts determine random uncertainty and systematic (bias from the standard) error of the measurement process. The combinations of these uncertainties determine the margin of error of the measurement process. The total measurement process error is determined by combining the margin of error and the uncertainty in the control standard. DOE

**N93-19870#** Defense Systems Management School, Fort Belvoir, VA.
**PROGRAM MANAGER: JOURNAL OF THE DEFENSE SYSTEMS MANAGEMENT COLLEGE, VOLUME 21, NUMBER 6, NOVEMBER-DECEMBER 1992**
Dec. 1992 43 p
(AD-A258766; DSMC-111-Vol-21-No-6) Avail: CASI HC A03/MF A01

The following topics dealing with real time software manipulation for weapons systems are discussed: cutting a path to quality through concurrent teamwork; manufacturing notes; lessons learned in manufacturing modernization; the army reuse center-cost avoidance through software reuse; results-oriented program management as a leadership/management model; organization development; the software development process; evolutionary acquisition and DOD's revised acquisition strategy; annual reliability and maintainability symposium. GRA

## 39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

**N93-17952** ESDU International Ltd., London (England).
**STRESS ANALYSIS OF SINGLE LAP BONDED JOINTS**

Dec. 1992 29 p
(ESDU-92041; ISBN-0-85679-849-5) Avail: ESDU

ESDU 92041 introduces a FORTRAN program, available as ESDUpac 9241, for calculating the shear stress distribution in the adhesive along the joint; it is assumed invariant across the width of the joint. Two options are provided: a simple shear stress analysis (sometimes called shear lag analysis) which neglects all out-of-plane considerations and a flexible joint analysis of both shear and peel stresses. The joint geometry, adhesive and adherend properties, and load are the required input to the program. The first option allows analysis of either tension or shear loading and either elastic or inelastic adhesive properties. The second option only treats tension loading and elastic adhesive properties. In both bases the adherends may be of different thicknesses and/or different materials. In the case of the flexible joint analysis, when the adherends have different coefficients of thermal expansion account can be taken of stresses induced by temperature change from the stress free (curing) temperature. The simple shear stress analysis also provides the stress and strain distribution along the adherends. The program will accept a range of overlap lengths and/or adhesive shear moduli and will determine the case giving the smallest peak stress in the adhesive. Notes on typical adhesive stress distributions and possible failure modes are included and the theoretical background to the program is derived from first principles and explained in detail. The input to and output from the program are detailed and illustrated with a fully worked example. ESDU

**N93-17996*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**EXPERIMENTAL INVESTIGATION OF CYCLIC THERMOMECHANICAL DEFORMATION IN TORSION**
John R. Ellis, Michael G. Castelli (Sverdrup Technology, Inc., Brook Park, OH.), and Charles E. Bakis (Pennsylvania State Univ., University Park.)
Nov. 1992 29 p
(RTOP 510-01-50)
(NASA-TM-105938; E-7455; NAS 1.15:105938) Avail: CASI HC A03/MF A01

An investigation of thermomechanical testing and deformation behavior of tubular specimens under torsional loading is described. Experimental issues concerning test accuracy and control specific to thermomechanical loadings under a torsional regime are discussed. A series of shear strain-controlled tests involving the nickel-base superalloy Hastelloy X were performed with various temperature excursions and compared to similar thermomechanical uniaxial tests. The concept and use of second invariants of the deviatoric stress and strain tensors as a means of comparing uniaxial and torsional specimens is also briefly presented and discussed in light of previous thermomechanical tests conducted under uniaxial conditions. Author

**N93-17997** ESDU International Ltd., London (England).
**METHODS FOR IMPROVING DAMPING. PART 3: DAMPING MATERIAL DATA**
Dec. 1992 35 p
(ESDU-92001; ISBN-0-85679-851-7) Avail: ESDU

ESDU 92001 presents modulus and loss factor for 27 damping materials in the form of reduced temperature nomograms which allow the effects of frequency and temperature on those properties to be considered simultaneously. The data were supplied by 5 manufacturers, and their addresses in the UK and US are provided. The information is a necessary input in computational procedures, described in ESDU 91013, dealing with the application of layered damping treatments to beam- and plate-like structures. Notes are included on the measurement and reliability of the damping quantities that affect the variability allowances to be made when assessing a damping treatment for a particular application. Factors to be considered when selecting a damping material are discussed. Approximate relationships between the elastic properties of damping materials are given. ESDU

**N93-18030*#** Rockwell International Corp., Los Angeles, CA. North American Aircraft Operations.
**LOW COST, SPF ALUMINUM CRYOGENIC TANK STRUCTURE FOR ALS Final Report, Apr. 1989 - Jan. 1992**
Claire E. Anton, Perry Rasmussen, Curt Thompson, Richard Latham, C. Howard Hamilton, Ben Ren, Chimata Gandhi, and Dallis Hardwick 22
Sep. 1992 631 p
(Contract NAS1-18590; RTOP 946-01-00-83)
(NASA-CR-189654; NAS 1.26:189654; NA-92-1097; Rept-92HP-0084-053)
Avail: CASI HC A99/MF A06

Past production work has shown that cryogenic tank structure for the Shuttle Booster Rockets and the Titan system have very high life cycle costs for the fuel tank structure. The tanks are machined stiffener-skin combination that are subsequently formed into the required contour after machining. The material scrap rate for these configurations are usually high, and the loss of a tank panel due to forming or heat treatment problems is very costly. The idea of reducing the amount of scrap material and scrapped structural members has prompted the introduction of built-up structure for cryogenic tanks to be explored on the ALS program. A build-up structure approach that has shown improvements in life cycle cost over the conventional built-up approach is the use of superplastically formed (SPF) stiffened panels (reducing the overall part count and weight for the tank) resistance spot welded (RSW) to outer tank skin material. The stiffeners provide for general stability of the tank, while the skin material provides hoop direction continuity for the loads. Author

**N93-18045** ESDU International Ltd., London (England).
**RESPONSE OF STRUCTURES TO ATMOSPHERIC TURBULENCE: COMPUTER PROGRAMS A9236 AND B9236**
Dec. 1992 43 p Supersedes ESDU 88036 and 90011
(ESDU-92036; ISBN-0-85679-842-8) Avail: ESDU

ESDU 92036 introduces ESDUpacs A9236 and B9236 for the calculation of response of structures due to respectively the along-wind and across-wind components of turbulence. The first program is based on ESDU 87035 and 88019, while the second is based on ESDU 89049. Four separate cases may be treated. The first is a uniform ground-based vertical cantilever, and responses are deflection and acceleration at the top and bending moment at the base. The second is a uniform line-like structure that may be inclined in the cross-wind plane with its base above ground level; responses are deflection, acceleration and bending moment at mid-span of a single-span structure, or deflection and acceleration at the tip, and bending moment at the base, of a cantilever. The final cases are for non-uniform structures with mass distribution and width varying along the structure. For the non-uniform ground-based cantilever, deflection, acceleration, shear force and bending moment at any height may be requested. For the non-uniform general case, the structure may be inclined in the cross-wind plane and the base may be above ground; responses for such cantilevered structures are the same as for the uniform ground-based cantilever, while for a single-span structure deflection and acceleration may be requested at any height with, for fixed or pinned ends, the shear force at the ends and the bending moment at mid-span and, additionally, for fixed ends only, the bending moment at the ends. The programs are provided on disc as source code with file input/output, and compiled with a user-friendly front end that prompts on screen for the input data, both for use under PC DOS. ESDU

**N93-18046** ESDU International Ltd., London (England).
**EQUIVALENT LENGTHS OF STRUTS (FOR USE IN BUCKLING CALCULATIONS)**
Nov. 1992 15 p
(ESDU-92038; ISBN-0-85679-846-0) Avail: ESDU

ESDU 92038 gives equivalent lengths that may be used in place of the true length in the Euler buckling equation for a uniform section strut pinned at both ends, so taking account of end conditions and loading type in the assessment of the buckling load of practical struts having initial bow and offset loading. The equivalent lengths are provided for a wide range of end conditions for uniform section struts, struts tapered continuously or tapered at both ends with a uniform section center portion, and struts with an intermediate support at which there may also be a step section change. The loadings include simple end loads and axially distributed loadings that vary linearly or to a power law; they may be conservative (fixed in direction) or non-conservative (tangential to the strut axis). Non-conservative distributed loads that are reacted by a conservative load at one or both ends are also included. The special case of a cantilevered uniform section strut that is clamped and has a direct loading inclined to the strut axis acting through a point on the neutral axis is treated. The equivalent length for dynamic buckling under a non-conservative loading is also given. ESDU

**N93-18080#** Societe Europeenne de Propulsion, Vernon (France). Div. Grosse Propulsion a Liquides.
**RESIDUAL CONTACT STRESSES IN CRYOTECHNICAL ENVIRONMENTS [CONTRAINTES RESIDUELLES DE CONTACT EN AMBIANCE CRYOTECHNIQUE]**
J. F. Cretegny and J. M. deMonicault 1992 22 p In FRENCH Presented at Colloque Contraintes Residuelles France-Portugal, Luso-Bucaco, Portugal, 28-30 Apr. 1992
(ETN-93-93020) Avail: CASI HC A03/MF A01

Two examples were chosen to show the use of residual stress measurements in the evaluation and comprehension of possible ruptures of parts subjected to the working conditions of cryogenic turbomachines which induce wear of the surfaces in dry contact. The examples concern the ball bearings and spline of the liquid hydrogen pump of the Vulcain engine to be used on Ariane 5. The Ariane program is introduced and tribological problems of the cryogenic technique are discussed. The utility of the residual stress measurements is assessed. ESA

**N93-18090*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**THREE-DIMENSIONAL ELASTIC-PLASTIC FINITE-ELEMENT ANALYSES OF CONSTRAINT VARIATIONS IN CRACKED BODIES**
J. C. Newman, Jr., C. A. Bigelow, and K. N. Shivakumar (North Carolina Agricultural and Technical State Univ., Greensboro.) Jan. 1993 44 p
(RTOP 505-63-50-04)
(NASA-TM-107704; NAS 1.15:107704) Avail: CASI HC A03/MF A01

Three-dimensional elastic-plastic (small-strain) finite-element analyses were used to study the stresses, deformations, and constraint variations around a straight-through crack in finite-thickness plates for an elastic-perfectly plastic material under monotonic and cyclic loading. Middle-crack tension specimens were analyzed for thicknesses ranging from 1.25 to 20 mm with various crack lengths. Three local constraint parameters, related to the normal, tangential, and hydrostatic stresses, showed similar variations along the crack front for a given thickness and applied stress level. Numerical analyses indicated that cyclic stress history and crack growth reduced the local constraint parameters in the interior of a plate, especially at high applied stress levels. A global constraint factor alpha(sub g) was defined to simulate three-dimensional effects in two-dimensional crack analyses. The global constraint factor was calculated as an average through-the-thickness value over the crack-front plastic region. Values of alpha(sub g) were found to be nearly independent of crack length and were related to the stress-intensity factor for a given thickness. Author

**N93-18204#** Naval Undersea Warfare Center, New London, CT.
**THE DIRECT MEASUREMENT OF DAMPING COEFFICIENTS USING AN INVERSE EIGENVALUE METHOD**
Stephen A. Austin, Andrew J. Hull, Kent D. Kasper, and David A. Hurdis 6 Nov. 1992 17 p
(AD-A258214; NUWC-NL-TR-10-195) Avail: CASI HC A03/MF A01

A direct measurement technique to identify the viscous damping coefficient of one-dimensional devices has been developed. The frequency-dependent properties of the damping coefficient are inherent in this formulation. It has been shown that the variance in the prediction of the damping coefficient is small. The experimental apparatus is extremely easy to build, and the raw data necessary to make the calculations are readily obtained with standard modal techniques. GRA

**N93-18327#** Naval Postgraduate School, Monterey, CA.
**OPTIMUM DESIGN OF ISOTROPIC MONOCOQUE AND RING-STIFFENED CIRCULAR CYLINDRICAL SHELLS SUBJECT TO EXTERNAL HYDROSTATIC PRESSURE M.S. Thesis**
Henry A. Castillo, Jr. Jun. 1992 134 p
(AD-A257864) Avail: CASI HC A07/MF A02

The objective of this research is to create a flexible code which is to be used in the investigation of optimum (minimum weight) shell designs. A shell analysis/design program, DAPS3, and a general purpose numerical optimization program, ADS, are incorporated into a single code, THESIS. This code provides the user great flexibility in changing the design variables and constraints which model the optimization problem. The optimum designs produced by this code are compared to DAPS3 optimum designs in order to identify any improvements made by the numerical optimization technique. GRA

**N93-18343#** Naval Postgraduate School, Monterey, CA.
**FACTORS INFLUENCING THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF ULTRA LOW CARBON BAINITIC 100 TUNGSTEN INERT GAS MULTIPASS WELDMENTS M.S. Thesis**
Eugene P. McDonald Sep. 1992 65 p
(AD-A257853) Avail: CASI HC A04/MF A01

The U.S. Navy has maintained a continuous research, development and certification program in HSLA and ULCB steels with the intent of someday totally replacing the HY steels now used in ship construction. A major advantage in using HSLA and ULCB steels is their increase in weldability over the HY steels which now require large amounts of preheating to prevent crack formation in the heat affected zone. Up until the present day, however, low carbon HSLA and ULCB steels have not been used with a dedicated low carbon weld wire. In the present work an attempt was made to correlate the mechanical properties (tensile strength, yield strength and Charpy impact energy), chemical composition and microstructure of a series of autogenous multirun TIG welds on ULCB steels. It was found that good combinations of weld strength and toughness could be achieved with appropriate choice of weld metal chemistry and TIG welding power, but that there was a ceiling of about 2.0 wt. percent molybdenum which could be tolerated before weld metal embrittlement became evident. GRA

**N93-18374*#** Anco Engineers, Inc., Culver City, CA.
**PROVIDING STRUCTURAL MODULES WITH SELF-INTEGRITY MONITORING Final Report**
W. B. Walton, P. Ibanez, and G. Yessaie Aug. 1988 353 p
(Contract NAS7-961)
(NASA-CR-190887; NAS 1.26:190887) Avail: CASI HC A16/MF A03

With the advent of complex space structures (i.e., U.S. Space Station), the need for methods for remotely detecting structural damage will become greater. Some of these structures will have hundreds of individual structural elements (i.e., strut members). Should some of them become damaged, it could be virtually impossible to detect it using visual or similar inspection techniques. The damage of only a few individual members may or may not be a serious problem. However, should a significant number of the members be damaged, a significant problem could be created. The implementation of an appropriate remote damage detection scheme would greatly reduce the likelihood of a serious problem related to structural damage ever occurring. This report presents the results of the research conducted on remote structural damage detection approaches and the related mathematical algorithms. The research was conducted for the Small Business Innovation and Research (SBIR) Phase 2 National Aeronautics and Space Administration (NASA) Contract NAS7-961. Author

**N93-18426*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**DYNAMICS OF ROTATING MULTI-COMPONENT TURBOMACHINERY SYSTEMS**
Charles Lawrence Jan. 1993 14 p Presented at the 34th Structures, Structural Dynamics, Materials Conference, La Jolla, CA, 19-21 Apr. 1993; sponsored by AIAA
(RTOP 505-63-53)
(NASA-TM-105997; E-7537; NAS 1.15:105997) Avail: CASI HC A03/MF A01

The ultimate objective of turbomachinery vibration analysis is to predict both the overall, as well as component dynamic response. To accomplish this objective requires complete engine structural models, including multistages of bladed disk assemblies, flexible rotor shafts and bearings, and engine support structures and casings. In the present approach each component is analyzed as a separate structure and boundary information is exchanged at the inter-component connections. The advantage of this tactic is that even though readily available detailed component models are utilized, accurate and comprehensive system response information may be obtained. Sample problems, which include a fixed base rotating blade and a blade on a flexible rotor, are presented. Author

**N93-18524#** Sandia National Labs., Albuquerque, NM.
**ELASTIC DYNAMICS OF A COMPLETE WIND TURBINE STRUCTURE: THEORETICAL DEVELOPMENT**
D. W. Lobitz, J. G. Arguello, and P. S. Veers 1992 6 p Presented at the Windpower 1992, Seattle, WA, 19-23 Oct. 1992

(Contract DE-AC04-76DP-00789)
(DE93-002478; SAND-92-1061C; CONF-921049-3) Avail: CASI HC A02/MF A01

A pseudo-linear formulation of the equations of motion for analyzing elastic bodies which undergo large rotations relative to one another with an emphasis on its application to horizontal axis wind turbines (HAWT) is developed. This procedure greatly simplifies the computational aspects of the solution algorithm over the nonlinear alternatives and should yield a significant improvement in computer speed. Additional speed can be achieved by ordering the nodes such that a minimum bandwidth can be realized (leading to approximately 64 multiplications per degree of freedom per solution step). The formulation utilizes a set of nested moving coordinate systems, each of which is loosely tied to one of the elastic bodies such that the displacements in the body relative to its coordinate system remain small. The formulation also includes a scheme for handling the nonlinear geometric stiffness that occurs in the blades as a result of the centrifugal loads in a pseudo-linear fashion. DOE

**N93-18576*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
**BASIC RESEARCH ON DESIGN ANALYSIS METHODS FOR ROTORCRAFT VIBRATIONS Semiannual Progress Report, 21 Jun. - 20 Dec. 1991**
S. Hanagud Dec. 1991 24 p
(Grant NAG1-1007)
(NASA-CR-191917; NAS 1.26:191917) Avail: CASI HC A03/MF A01

The objective of the present work was to develop a method for identifying physically plausible finite element system models of airframe structures from test data. The assumed models were based on linear elastic behavior with general (nonproportional) damping. Physical plausibility of the identified system matrices was insured by restricting the identification process to designated physical parameters only and not simply to the elements of the system matrices themselves. For example, in a large finite element model the identified parameters might be restricted to the moduli for each of the different materials used in the structure. In the case of damping, a restricted set of damping values might be assigned to finite elements based on the material type and on the fabrication processes used. In this case, different damping values might be associated with riveted, bolted and bonded elements. The method itself is developed first, and several approaches are outlined for computing the identified parameter values. The method is applied first to a simple structure for which the 'measured' response is actually synthesized from an assumed model. Both stiffness and damping parameter values are accurately identified. The true test, however, is the application to a full-scale airframe structure. In this case, a NASTRAN model and actual measured modal parameters formed the basis for the identification of a restricted set of physically plausible stiffness and damping parameters. Author

**N93-18609*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
**MODELING OF COMPOSITE BEAMS AND PLATES FOR STATIC AND DYNAMIC ANALYSIS Final Report, 17 Jan. 1990 - 16 Jan. 1993**
Dewey H. Hodges, Vladislav G. Sutyrin, and Bok Woo Lee 1993 16 p
(Grant NAG1-1094)
(NASA-CR-192222; NAS 1.26:192222) Avail: CASI HC A03/MF A01

The main purpose of this research was to develop a rigorous theory and corresponding computational algorithms for through-the-thickness analysis of composite plates. This type of analysis is needed in order to find the elastic stiffness constants for a plate and to post-process the resulting plate solution in order to find approximate three-dimensional displacement, strain, and stress distributions throughout the plate. This also requires the development of finite deformation plate equations which are compatible with the through-the-thickness analyses. After about one year's work, we settled on the variational-asymptotical method (VAM) as a suitable framework in which to solve these types of problems. VAM was applied to laminated plates with constant thickness in the work of Atilgan and Hodges. The corresponding geometrically nonlinear global deformation analysis of plates was developed by Hodges, Atilgan, and Danielson. A different application of VAM, along with numerical results, was obtained by Hodges, Lee, and Atilgan. An expanded version of this last paper was submitted for publication in the AIAA Journal. Author

**N93-18615*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**EFFECT OF BOW-TYPE INITIAL IMPERFECTION ON RELIABILITY OF MINIMUM-WEIGHT, STIFFENED STRUCTURAL PANELS**
W. Jefferson Stroud, Thiagaraja Krishnamurthy (Analytical Services and Materials, Inc., Hampton, VA.), Nancy P. Sykes (Analytical Services and Materials, Inc., Hampton, VA.), and Isaac Elishakoff (Florida Atlantic Univ., Boca Raton.) Washington Jan. 1993 27 p
(RTOP 505-63-53-01)
(NASA-TP-3263; L-17089; NAS 1.60:3263) Avail: CASI HC A03/MF A01

Computations were performed to determine the effect of an overall bow-type imperfection on the reliability of structural panels under combined compression and shear loadings. A panel's reliability is the probability that it will perform the intended function - in this case, carry a given load without buckling or exceeding in-plane strain allowables. For a panel loaded in compression, a small initial bow can cause large bending stresses that reduce both the buckling load and the load at which strain allowables are exceeded; hence, the bow reduces the reliability of the panel. In this report, analytical studies on two stiffened panels quantified that effect. The bow is in the shape of a half-sine wave along the length of the panel. The size e of the bow at panel midlength is taken to be the single random variable. Several probability density distributions for e are examined to determine the sensitivity of the reliability to details of the bow statistics. In addition, the effects of quality control are explored with truncated distributions. Author

**N93-18700#** Technical Research Centre of Finland, Espoo. Metals Lab.
**SOME REMARKS UPON FRACTURE MECHANICS**
Kari Santaoja May 1992 71 p Sponsored by Valmet Corp.; Advanced Composites Oy; NESTE Chemicals; and Technology Development Center of Finland
(VTT-Pubs-100; ISBN-951-38-4078-6; ETN-93-93075) Copyright Avail: CASI HC A04/MF A01

A study on the basics of fracture mechanics is presented. The theory proposed by Griffith is derived starting from the examination of the momentum and moment of momentum principles. A condition for crack growth is formulated. This equation also contains the influence of kinetic energy and continuum dissipation. The condition is expressed in the rate form, that is, it describes the response of a continuum in the case of a running crack. In the special case, the derived condition reduces to that proposed by Griffith. Seven sufficient conditions for the path independency of the J integral are derived. The mathematical treatment of unbounded functions due to the crack tip is also considered, the relation between the J integral and the potential energy being examined. Results showed that if a pure elastic deformation and crack tip singularity is assumed a previously not derived term has to be added to the above mentioned relationship. A computed example which studies the mode I of cracking and assumes a linear elastic, isotropic material behavior shows that the value of this new term equals that of the J integral. ESA

**N93-18749#** Technical Research Centre of Finland, Espoo. Ship Lab.
**STRUCTURAL ANALYSIS 1992 [RAKENNE-ANALYYSI 1992]**
Timo P. J. Mikkola, ed. 1992 174 p Symposium held in Espoo, Finland, 17-18 Mar. 1992
(VTT-Symp-128; ISBN-951-38-3959-1; ETN-92-92265) Copyright Avail: CASI HC A08/MF A02

Papers on the following topics are presented: structural integrity, quality and result accuracy, and structural dynamics. The special theme for the seminar was quality and result accuracy. The research program concentrated on numerical methods for structural analysis and developed a basis for the quality system of structural analysis. The applications dealt with practical engineering problems ranging from the analysis of defected or cracked components under fatigue or high temperature loading to vibration analysis of large structures. For individual titles, see N93-18750 through N93-18760.

**N93-18750#** Technical Research Centre of Finland, Espoo. Ship Lab.
**NUMERICAL ANALYSIS OF SURFACE CRACKS**
Timo P. J. Mikkola *In its* Structural Analysis 1992 1992 p 7-24 Sponsored by TVO and Imatran Voima Oy (For primary document see

N93-18749 06-39)
Copyright Avail: CASI HC A03/MF A02

A program system for fracture assessment of surface cracked structures was developed. The system consists of an easy program for engineering analysis applications and an automated finite element program system for more accurate analysis. The three dimensional finite element model of a cracked structure is automatically generated. The finite element analyses are made with accepted commercial programs. The virtual crack extension method is used for fracture parameter evaluation by the Technical Research Center of Finland VIRT postprocessor program. The stress intensity factor program for engineering fracture assessment applies either the weight function method or superposition method in calculating the stress intensity factor. The fatigue crack growth analysis is based on the Paris equation. Several test cases demonstrated that the accuracy of the present system is satisfactory for practical applications. ESA

**N93-18751#** Imatran Voima Oy, Vantaa (Finland). Research and Development.
**HIGH TEMPERATURE COMPONENT ANALYSIS WITH EXPERT SYSTEMS**
Juhani Rantala *In* Technical Research Centre of Finland, Structural Analysis 1992 1992 p 25-35 (For primary document see N93-18749 06-39)
Copyright Avail: CASI HC A03/MF A02

The development of an expert system designed for life assessment of high temperature components, especially at steam pipings at the first stage, is presented. The system is used for storing and managing inspection data. Stress analysis techniques form an integral part of the system. One of the key features of this system is its ability to manage and interpret inspection data. The expert system is also designed to: perform life time calculations on the basis of the stress analysis; make a probabilistic analysis based on boundary conditions; interpret the results of all the analyses performed; make a damage analysis; and include a case study data bank. From the data analysis reliable remanent life estimates for the critical components are obtained. ESA

**N93-18752#** Technical Research Centre of Finland, Espoo. Ship Lab.
**FIBRE REINFORCED PLASTIC STRUCTURES**
Martin Hildebrand *In its* Structural Analysis 1992 1992 p 37-52 (For primary document see N93-18749 06-39)
Copyright Avail: CASI HC A03/MF A02

The applicability of different finite element codes for the analysis of laterally loaded curved sandwich panels is investigated. The influence of the curvature of sandwich panels on the bending behavior, face strain, and the transverse shear strain distributions is examined using nonlinear finite element methods. The behavior under two different load types, a constant pressure distribution and a slamming pressure distribution is analyzed. Different types of bending responses depending on the curvature of the sandwich panels are found. The results show that it is necessary to perform a geometric nonlinear analysis in order to get reliable results for these types of structures. For panels with higher curvature, transverse shear strains decrease by 50 to 90 percent when compared to flat plates. ESA

**N93-18753#** Technical Research Centre of Finland, Espoo. Metals Lab.
**MATHEMATICAL MODELLING OF MATERIALS**
Kari Santaoja *In its* Structural Analysis 1992 1992 p 53-58 (For primary document see N93-18749 06-39)
Copyright Avail: CASI HC A02/MF A02

Different ways to derive constitutive equations for materials are investigated. The aim of the mathematical modeling of materials is to derive equation(s) that can be used in the mathematical simulation of the response of materials under different loading conditions. Mathematical simulation can be carried out either analytically or numerically. In most cases, the assumptions made for an analytical solution restrict the quality of the results. They often lead to a solution that cannot describe the natural event, and in many cases the value of an analytical simulation is limited. Numerical simulation gives the possibility to include important details, rejected by analytical methods. The main problems in numerical simulation are the lack of computing capacity and the lack of reliable equations that describe the natural event. In the formulation of new material models, a correlation between micromechanical examination and thermodynamics is recommended. ESA

**N93-18754#** Technical Research Centre of Finland, Espoo. Fire Technology Lab.
**ANALYSIS OF STRUCTURES UNDER FIRE CONDITIONS**
Juri Kajaste-Rudnitski *In its* Structural Analysis 1992 1992 p 59-77 (For primary document see N93-18749 06-39)
Copyright Avail: CASI HC A03/MF A02

The prospect of the application of a standard finite element method program to study the ability of a structure to withstand fire is studied. The objective of using a finite element method program for structure fire resistance evaluation is to compliment, if not to substitute, the expensive fire tests of the natural size structural elements. Besides, an existing measurement technique provides limited scope of data: the temperature and displacement at the reference points of the structure. Furthermore, the simulation of the real fire situation is rather difficult in the laboratory conditions. The numerical model of the concrete type of material with temperature dependent properties is studied. The standard finite element method program ABAQUS chosen for this purpose enables users to create their own subroutines and insert them into the main program. ESA

**N93-18755#** Technical Research Centre of Finland, Espoo. Nuclear Engineering Lab.
**QA SYSTEM FOR STRUCTURAL ANALYSIS**
Heikki Raiko *In its* Structural Analysis 1992 1992 p 79-92 (For primary document see N93-18749 06-39)
Copyright Avail: CASI HC A03/MF A02

The activities to be addressed by an organization involved in structural analysis by numerical methods and/or development and maintenance of such computer codes or systems are described. The requirements are based on International Standard 9001. The interpretation of the requirements is done according to an application presented by a Quality Analysis (QA) working group. The purpose of a quality analysis system is to help anyone to do a better job. Emphasis on technical documentation to speed up operations is recommended. The first steps in implementing a finite element quality assurance system in an organization are as follows: constitute a technical body with responsibility and authority for the analysis quality system; agree on management responsibilities for each quality analysis activity; and review current practices against the quality system standard requirements. Experience shows that it is mainly a process of rationalizing, formalizing, and reinforcing existing practices. ESA

**N93-18756#** Imatran Voima Oy, Vantaa (Finland).
**P-ADAPTIVITY APPLIED TO PLATE IN BENDING PROBLEMS**
Seppo Orivuori *In* Technical Research Centre of Finland, Structural Analysis 1992 1992 p 95-107 (For primary document see N93-18749 06-39)
Copyright Avail: CASI HC A03/MF A02

A p-adaptive method to solve the plate in bending problems within a preset accuracy is presented. Software refinement for error analysis can be done using h, p, or hp method. In an h method the dimensions of the elements are modified. In a p method the orders of the approximating polynomials are raised within the elements. An hp method is a combination of the two. A measure for the finite element method induced errors having physical meaning is presented. The Reissner-Mindlin theory for both thin and thick plates are summarized. The jumps in stress resultants at the inter-element boundaries and the lack of satisfaction of the governing equations are transformed into physical quantities. The hierarchical modes used to refine the solution are presented. Examples applying the adaptive system described, are included. ESA

**N93-18757#** Technical Research Centre of Finland, Espoo. Ship Lab.
**FINITE ELEMENT ANALYSIS OF STIFFENED PLATE VIBRATIONS**
Timo Holopainen *In its* Structural Analysis 1992 1992 p 109-123 (For primary document see N93-18749 06-39)
Copyright Avail: CASI HC A03/MF A02

A new stiffened plate bending element for the vibration analysis of stiffened plate structures is presented. The element can include the stiffeners anywhere within the element. The method can be called the master element technique. By this method the geometry idealization error can be reduced considerably, because there is no need to make remarkable geometrical

simplifications. The use of master element technique leads to an introduction of a stiffened plate element. The aim in the formulation of this element is to overcome the shear locking problems. By these elements the mesh generation can be carried out without the geometry idealization error following from the simplification of the geometry. The method gives more freedom to choose the number and the distribution of the degrees of freedom. Numerical examples of the vibration analysis of stiffened plates are presented. ESA

**N93-18758#** Technical Research Centre of Finland, Espoo. Production Engineering Lab.

**DYNAMICS IN CONDITION MONITORING, A CASE STUDY**

Erkki Jantunen and Antti Poikonen *In its* Structural Analysis 1992 1992 p 125-138 (For primary document see N93-18749 06-39)

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An attempt to simulate the vibration of a gearbox during accelerated wear tests in a laboratory is presented. The natural frequencies and corresponding vibration modes of the shaft, gear, and supporting structure are calculated with simplified finite element models. Based on results from oil analysis and vibration measurements, a numerical formula describing the wear of the gear teeth during the test runs is developed. Dynamic loads in gear teeth are calculated as a function of wear. These loads together with vibration excitation from bearings and unbalance are used to calculate the dynamic response. Four calculations are performed during the lifetime of the gearbox. The results from dynamic response calculations are analyzed with a fast Fourier transformation analyzer using the same methods of analysis as were used in the laboratory tests. ESA

**N93-18759#** Technical Research Centre of Finland, Espoo. Structural Engineering Lab.

**MODELLING OF DYNAMIC SOIL-STRUCTURE-ICE INTERACTION**

Tuomo Karna *In its* Structural Analysis 1992 1992 p 139-157 (For primary document see N93-18749 06-39)

Copyright Avail: CASI HC A03/MF A02

A computer model was developed for evaluating the dynamic ice-structure interaction. The effects of soil structure interaction are included in the model. The program can be used in the analysis of events, where an offshore structure is subjected to the action of drifting ice sheets or massive ice features like an iceberg. The new approach is based on a generalized modeling of the ice crushing process which takes into account the dependence of ice load on relative displacement and relative velocity between the ice edge and the structure. A substructure technique, where separate equations are set up for each of the interacting medium, is considered. A zonal approach is applied while modeling the ice failure processes. The effects of nonsimultaneous crushing are considered. ESA

**N93-18760#** Technical Research Centre of Finland, Espoo. Ship Lab.

**SHOCK AND IMPACT DYNAMICS**

Markku Juntunen *In its* Structural Analysis 1992 1992 p 159-179 (For primary document see N93-18749 06-39)

Copyright Avail: CASI HC A03/MF A02

The main principles of shock and impact dynamics are presented. Transient signal analysis, measurement of transients, shock testing, shock design methods and numerical simulation of transients, are included. Shock and transient vibration problems can be very complicated and measurement and analysis of them can be difficult. Modern methods used in measurement, analysis and design of structures give powerful tools to study complicated transient problems. The difficulties lie in high frequency components of the measured or simulated phenomenon, meaningful interpretation of the results, the cost of computer simulation and the cost of model and full scale testing. When carefully used, quite simple methods can be used to solve shock problems and to design equipment for severe shock environments. Numerical simulation is an increasingly important technique to study problems, such as nonlinear materials and multifield interactions. ESA

**N93-18765*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX. Thermal Branch.

**THERMAL PROTECTION MATERIALS: THERMOPHYSICAL PROPERTY DATA**

S. D. Williams (Lockheed Engineering and Sciences Co., Houston, TX.) and Donald M. Curry Washington Dec. 1992 204 p

(NASA-RP-1289; S-693; NAS 1.61:1289) Avail: CASI HC A10/MF A03

This publication presents a thermophysical property survey on materials that could potentially be used for future spacecraft thermal protection systems (TPS). This includes data that was reported in the 1960's as well as more current information reported through the 1980's. An attempt was made to cite the manufacturers as well as the data source in the bibliography. This volume represents an attempt to provide in a single source a complete set of thermophysical data on a large variety of materials used in spacecraft TPS analysis. The property data is divided into two categories: ablative and reusable. The ablative materials have been compiled into twelve categories that are descriptive of the material composition. An attempt was made to define the Arrhenius equation for each material although this data may not be available for some materials. In a similar manner, char data may not be available for some of the ablative materials. The reusable materials have been divided into three basic categories: thermal protection materials (such as insulators), adhesives, and structural materials. Author

**N93-18875*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**STRUCTURAL DYNAMIC TESTING OF COMPOSITE PROPFAN BLADES FOR A CRUISE MISSILE WIND TUNNEL MODEL**

Stephen D. Elgin and Thomas J. Sutliff Feb. 1993 19 p

(RTOP 535-03-0B)

(NASA-TM-105272; E-6663; NAS 1.15:105272) Avail: CASI HC A03/MF A01

The Naval Weapons Center at China Lake, California is currently evaluating a counter rotating propfan system as a means of propulsion for the next generation of cruise missiles. The details and results of a structural dynamic test program are presented for scale model graphite-epoxy composite propfan blades. These blades are intended for use on a cruise missile wind tunnel model. Both dynamic characteristics and strain operating limits of the blades are presented. Complications associated with high strain level fatigue testing methods are also discussed. Author

**N93-18876*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**INVERSE KINEMATICS PROBLEM IN ROBOTICS USING NEURAL NETWORKS**

Benjamin B. Choi and Charles Lawrence Oct. 1992 24 p

(RTOP 506-43-41)

(NASA-TM-105869; E-7333; NAS 1.15:105869) Avail: CASI HC A03/MF A01

In this paper, Multilayer Feedforward Networks are applied to the robot inverse kinematic problem. The networks are trained with endeffector position and joint angles. After training, performance is measured by having the network generate joint angles for arbitrary endeffector trajectories. A 3-degree-of-freedom (DOF) spatial manipulator is used for the study. It is found that neural networks provide a simple and effective way to both model the manipulator inverse kinematics and circumvent the problems associated with algorithmic solution methods. Author

**N93-18953#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**THE NON-LINEAR DYNAMICS OF COMPOSITE CYLINDRICAL SHELLS M.S. Thesis**

James M. Greer, Jr. 15 Dec. 1992 108 p

(AD-A259026; AFIT/GAE/ENG/92D-06) Avail: CASI HC A06/MF A02

The non-linear dynamic behavior of suddenly loaded composite shells is addressed. The objective of the research is two-fold: (1) to characterize the apparently random physical behavior sometimes observed in the finite element analysis as either numerical instability, chaotic behavior, or both; and (2) to develop criteria for choosing time steps for the finite element model, referred to as DSHELL. This displacement based finite element code is capable of dynamic analysis of plates, arches, and cylindrical shells undergoing large displacements and moderately large rotations during deformation. DSHELL uses a 36-DOF isoparametric shell element to obtain numerical results. A simplified shell model (MSHELL) is developed to provide a shell analog that requires much less computer time to run than the full-up finite element model. The results of the investigations using this simplified model are then applied toward understanding behavior seen in the finite element code. The simplified model and the composite shell exhibit chaotic behavior after collapse. For loads not sufficient to cause collapse, the composite shell experiences oscillations at the panel edges

of a type associated with near-chaotic behavior. Significant in-plane oscillations (parametric resonances) are exhibited by the suddenly-loaded composite shell. Extensive use of the Fast Fourier Transform (FFT) is made to investigate behavior of the MSHELL and DSHELL models in the frequency domain. The composite shell is compared to an isotropic shell of identical physical dimensions and static collapse strength, showing the primary effect of isotropy to be increased flexibility in all displacement directions. A method is developed using MSHELL for choosing appropriate time steps for analyses using DSHELL. GRA

**N93-18986#** Northwestern Univ., Evanston, IL. Dept. of Materials Science and Engineering.

**SOME RECENT RESULTS ON STRESSES IN THIN FILMS AND PRECIPITATES**

J. B. Cohen Oct. 1992 20 p

(AD-A258807; TR-33) Avail: CASI HC A03/MF A01

Diffraction remains the premier tool for sampling the residual stresses in materials non destructively, the only one capable of determining the entire stress tensor, and with few assumptions. The technique has kept pace with the needs of researchers in the area of multiphase materials; now, the stresses can be separated into macro and micro components. The deviatoric macro and micro stress components and hydrostatic macrostress can be measured without knowledge of the unstressed lattice parameter. Bond strength of film and fiber and the yield stress can be examined by cooling samples, and there are new developments that enable gradients to be determined. GRA

**N93-18998#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**AN EXPERIMENTAL DETERMINATION OF THE EFFECTS OF BLENDING COLLOCATED AND NON-COLLOCATED SENSOR MEASUREMENTS TO CONTROL A FLEXIBLE STRUCTURE M.S. Thesis**

Richard G. Cobb Dec. 1992 133 p

(AD-A258823; AFIT/GA/ENY/92D-07) Avail: CASI HC A07/MF A02

An experimental investigation was performed controlling a cantilevered beam in bending using proportional feedback on a blend of collocated and non-collocated sensor measurements using a single actuator. Exact transfer functions between the control input and the measurements were developed and compared to the finite element method. By analyzing the open loop pole-zero locations as a function of the measurement blending, insight into the closed loop behavior is obtained. Minimum phase behavior can be maintained for a range of the blending ratio. Results using blended control were compared to both proportional collocated feedback and compensated collocated feedback using LQG methods. The comparison was then extended to a theoretical investigation using the blended measurements on a free-free torsional model analogous to a gimbal. Advantages and limitations of using blended measurements are presented. GRA

**N93-19042** Carleton Univ., Ottawa (Ontario).

**FATIGUE CRACK GROWTH AND COALESCENSE IN A NOTCH REGION Ph.D. Thesis**

Peter Richard Frise 1990 175 p

(ISBN-0-315-68910-2) Avail: Univ. Microfilms Order No. DANN68910

An experimental and analytical study of the process of fatigue crack growth and coalescence in the region of a notch has been performed. The experimental program consisted of constant amplitude fatigue tests of 24 steel bar specimens. Each bar had a 135 deg vee notch machined across the middle. An important part of the experimental program was the monitoring of the fatigue cracks by the Alternating Current Potential Drop (ACPD) method. To better understand this technique, a preliminary part of the test program was a study of the electric field induced in the specimen by the ACPD equipment. This study showed that the field is not uniform. This has led to the development of a data collection probe array that compensates for this lack of uniformity and yields crack growth measurements that are accurate even before being calibrated with visible beachmarks after the completion of the test. The results of the experimental program are examined and compared to existing design codes that prescribe a method for dealing with adjacent cracks. It has been found in the present study that pre-coalescence interaction between adjacent cracks is not evident and, in fact, that coalescence itself is not an instantaneous process as the design codes suggest. Accordingly, a new crack shape development model has been developed that describes the coalescence process and accounts for the fact that the specimen has a finite width and the crack will eventually break through the edges and grow as a straight fronted crack. It has been concluded that the codes are over-conservative and are not realistic in the manner in which they treat the problem of adjacent fatigue cracks. The experimental results were compared to computer predictions of fatigue crack growth using software that performs an integration of the Paris crack growth law and incorporates the new crack shape development and crack coalescence mode. The predictions were found to agree reasonably well with the lives actually achieved by the test specimens. Dissert. Abstr.

**N93-19096#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**PASSIVE DAMPING OF A SOLAR ARRAY M.S. Thesis**

Mark A. Scharpen Dec. 1992 137 p

(AD-A258976; AFIT/GA/ENY/92D-13) Avail: CASI HC A07/MF A02

This study was an attempt to conceptualize, design, build, and test a constrained layer damping device that uses mechanical advantage for the purpose of increasing the damping of transient vibration of a five-bay planar truss. The aluminum truss was clamped to a fixed support and simulated a solar array. A conventional constrained layer treatment was designed, built, and tested to serve as a benchmark for comparison. For the conventional treatment, Plunkett and Lee's segmented constraining layer technique was used. The improved device, two three-layer sandwich beams spanning the two bays nearest the built-in end, were supported several inches away from the truss plane by a series of levers that were designed to impart a combined shear and bending load to the beam ends. Mindlin and Goodman's method was used to solve a sixth-order, homogeneous differential equation of motion with time-dependent boundary conditions. Experimental results showed that the sandwich beam device did not exceed the loss factors for any of the first four out-of-plane bending modes. However, measurable levels of system damping were achieved for all modes of interest, particularly at the mode whose frequency coincided with that of the sandwich beams. GRA

**N93-19329*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**HIGH SPEED THIN PLATE FATIGUE CRACK MONITOR Patent Application**

Buzz A. Wincheski, inventor (to NASA) (Analytical Services and Materials, Inc., Hampton, VA.), Joseph S. Heyman, inventor (to NASA), Min Namkung, inventor (to NASA), and James P. Fulton, inventor (to NASA) (Analytical Services and Materials, Inc., Hampton, VA.) 8 Dec. 1992 36 p

(NASA-Case-LAR-14816-1-SB; NAS 1.71:LAR-14816-1-SB; US-Patent-Appl-SN-988084) Avail: CASI HC A03/MF A01

A device and method are provided which non-destructively detect crack length and crack geometry in thin metallic plates. A non-contacting vibration apparatus produces resonant vibrations without introducing extraneous noise. Resulting resonant vibration shifts in cracked plates are correlated to known crack length in plates with similar resonant vibration shifts. In addition, acoustic emissions of cracks at resonance frequencies are correlated to acoustic emissions from known crack geometries. NASA

**N93-19353#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**NONLINEAR LARGE DISPLACEMENT AND MODERATE ROTATIONAL CHARACTERISTICS OF COMPOSITE BEAMS INCORPORATING TRANSVERSE SHEAR STRAIN M.S. Thesis**

Stephen G. Creaghan Dec. 1992 139 p

(AD-A258908; AFIT/GA/ENY/92D-10) Avail: CASI HC A07/MF A02

This research was directed toward the investigation of nonlinear large displacements and moderate rotations of composite beam structures considering a finite element potential energy approach incorporating through the thickness shear strain as an analytical function. This approach was compared to large rotation theories. Test cases were run to evaluate numerical algorithms Riks method and displacement imposed techniques were employed. The limitations and advantages of both methods were considered. Loading arrangements included concentrated forces as well as moments. GRA

**N93-19360#** Wichita State Univ., KS. National Inst. for Aviation Research.

**IMPACT RESPONSE OF LAMINATED PLATES SUBJECTED TO TRANSVERSE LOADING**

Gum Ho Choe and J. Chaudhuri Apr. 1992 138 p

(NIAR-92-5) Avail: CASI HC A07/MF A02

Results of an analytical solution and comprehensive experimental program to investigate the impact response of laminated plates subjected to transverse loading is presented. The objectives were to develop an efficient method to predict the maximum impact force from the energy-balance model and to assess the impact damage resistance. In the analytical study, the dynamic governing equations based on the classical laminate theory were expanded to obtain more generality. The derived equations of motion were solved in terms of natural frequency using Laplace transform. From Lagrangian equations of motion, the effective bending-shear stiffness of composite laminates was determined by using the fundamental natural frequency. This efficient approach can be used in place of the static compliance test conventionally conducted. A modified energy-balance model utilizing this stiffness predicted the maximum impact force at various impact energies using a numerical technique. Comprehensive experimental studies were performed utilizing the systematically designed instrumented drop weight tester to obtain the impact force vs. characteristic time of the AS4/APC-2 thermoplastic and AS4/3501-6 thermoset laminates at various energies, specimen configurations, and stress states. The experimental program included the assessment of damage and the analysis of failure mechanisms by ultrasonic C-scan and scanning electron microscope (SEM), respectively. The maximum impact force obtained from the analysis solution agreed well with the experimental data up to a certain impact energy for thermoplastic laminates due to their linear elastic characteristics. The data for thermoset composites, however, were not compatible with the solution because of the reduced bending-shear stiffness. In the analysis of experimental results, higher impact force and shorter characteristic time were correlated with smaller damage size. Thus, these parameters could be substituted for traditional absorbed energy criteria in assessing the impact damage resistance. The failure mechanisms of the increased damage resistance resulted from fiber pull-out and fiber breakage rather than wide delaminations. The data obtained provide a basis for improved design and analysis of composite structures subjected to dynamic loading. Further, a model created for impact parameters in this research can be applied to various composite materials. Author

**N93-19381** Cornell Univ., Ithaca, NY.

**INTERFACE FRACTURE IN COMPOSITE MATERIALS Ph.D. Thesis**

Yungchen Wang 1992 171 p

Avail: Univ. Microfilms Order No. DA9300852

The effect of interface debonding on the stiffness and fracture toughness of fiber-reinforced ceramic composite is studied based on micromechanical calculations of some model problems. Interface models that relate the displacement jumps and the tractions acting across the interfaces are employed during the investigation. The results obtained are used to elucidate the relationships between the progressive loss of stiffness and the development of inelastic behavior of composites with the underlying micromechanics of interface debonding and slip. Dissert. Abstr.

**N93-19440#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**BASELINE EXPERIMENTS ON COULOMB DAMPING DUE TO ROTATIONAL SLIP M.S. Thesis**

John P. Santacroce Dec. 1992 264 p

(AD-A258840; AFIT/GA/ENY/92D-08) Avail: CASI HC A12/MF A03

Two experimental pin-type joint models are developed to study the effects of Coulomb Damping due to rotational slip. Model One is an inverted beam allowed to pivot at one end as a pendulum. Model Two is a horizontally mounted beam allowed to pivot about its center. The equations of motion for the joint geometries, considering only macro-slip friction, are developed and solved. Theoretical and experimental results for the response of the models in vibration are presented showing energy dissipation versus clamping force for the joint(s). GRA

**N93-19473#** Sandia National Labs., Albuquerque, NM.

**THERMO-VISCO-INELASTICITY IN LARGE DEFORMATIONS**

W. Herrmann 10 Sep. 1992 16 p Presented at the Society of Engineering Science (SES) Technical Meeting, San Diego, CA, 14-16 Sep. 1992

(Contract DE-AC04-76DP-00789)

(DE93-002284; SAND-92-2083C; CONF-9209240-4) Avail: CASI HC A03/MF A01

A formulation is given of constitutive equations valid for large deformations of materials with elastic range and internal state variables intended to describe the internal structure of the material. A material description is used to construct a purely mechanical theory. The assumption that the work done in finite closed cycles of homogeneous deformation is non-negative, leads to an elastic potential and a dissipation inequality which, in turn, implies a normality condition. When the theory is generalized to include temperature dependence, the Clausius-Duhem inequality leads by well-known arguments to an elastic potential and nonnegative dissipation. Rate effects are included by assuming that the inelastic strain rate is a function of the dynamic overstress, but the results of the work assumption or the thermodynamic argument are unchanged. Some remarks regarding implications for stability are made. DOE

**N93-19476#** Oak Ridge National Lab., TN.

**A PERFORMANCE MODEL FOR THICK COMPOSITE CYLINDERS SUBJECTED TO EXTERNAL HYDROSTATIC PRESSURE**

J. M. Starbuck and H. W. Blake 1992 27 p Presented at the American Society for Testing and Materials (ASTM) Symposium on Application of Accelerated Corrosion Tests To Life Prediction of Materials, Miami, FL, 16-17 Nov. 1992

(Contract DE-AC05-84OR-21400)

(DE93-002425; CONF-921119-1) Avail: CASI HC A03/MF A01

Experimental results from implosion tests of various graphite/epoxy and glass/epoxy cylinders are correlated with predictions from a performance model for thick composite cylinders subjected to external hydrostatic pressure. The performance model consists of a stress module, a stability module, and a material failure module. The stress module predicts the ply level stresses and is based on an anisotropic elasticity solution for axisymmetric loading. The stability module predicts the critical buckling load based on a laminated orthotropic shell theory which includes transverse shear deformations. The failure module evaluates several existing failure criteria for composite laminates. The results from the correlation study led to the selection of an appropriate failure theory for thick laminated composite cylinders loaded in compression. Results from the Hashin criteria are seen to be consistent with observed experimental results provided that composite material strength allowables are based on a representative test and that appropriate solutions for cylinder stresses are used. Both the failure criteria and stress solution must allow for the three-dimensional stress state and for the discrete layer construction. Further applications of the performance model are demonstrated for a range of laminate constructions. These parametric studies provide insight to optimum designs for graphite/epoxy and glass/epoxy cylinders. DOE

**N93-19944*#** Tuskegee Inst., AL. School of Engineering and Architecture.

**DAMPING CHARACTERIZATION IN LARGE STRUCTURES Final Technical Report, 1 Jan. 1989 - 31 Dec. 1990**

Fidelis O. Eke and Estelle M. Eke 24 Jan. 1991 17 p

(Grant NAGw-1599)

(NASA-CR-192140; NAS 1.26:192140) Avail: CASI HC A03/MF A01

This research project has as its main goal the development of methods for selecting the damping characteristics of components of a large structure or multibody system, in such a way as to produce some desired system damping characteristics. The main need for such an analytical device is in the simulation of the dynamics of multibody systems consisting, at least partially, of flexible components. The reason for this need is that all existing simulation codes for multibody systems require component-by-component characterization of complex systems, whereas requirements (including damping) often appear at the overall system level. The main goal was met in large part by the development of a method that will in fact synthesize component damping matrices from a given system damping matrix. The restrictions to the method are that the desired system damping matrix must be diagonal (which is almost always the case) and that interbody connections must be by simple hinges. In addition to the technical outcome, this project contributed positively to the educational and research

infrastructure of Tuskegee University - a Historically Black Institution.
Author

**N93-18827*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**STATIC AND DYNAMIC CHARACTERISTICS OF A PIEZOCERAMIC STRUT**
Brett J. Pokines (State Univ. of New York, Buffalo.), W. Keith Belvin, and Daniel J. Inman (State Univ. of New York, Buffalo.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 133-140 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

**N93-18835*#** Lockheed Missiles and Space Co., Sunnyvale, CA.
**DESIGN, ANALYSIS, AND TESTING OF HIGH FREQUENCY PASSIVELY DAMPED STRUTS**
Y. C. Yiu, L. Porter Davis, Kevin Napolitano, and R. Rory Ninneman *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 239-249 Prepared in cooperation with Honeywell, Inc., Phoenix, AZ; CSA Engineering, Inc., Palo Alto, CA; and Phillips Lab., Kirkland AFB, NM (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

**N93-18836*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**A COMPARISON OF VISCOELASTIC DAMPING MODELS**
Joseph C. Slater (Buffalo Univ., NY.), W. Keith Belvin, and Daniel J. Inman (Buffalo Univ., NY.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 251-262 (For primary document see N93-18818 06-18)
(Grant NGT-50541)
Avail: CASI HC A03/MF A04

**N93-18837*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**STRUCTURAL CONTROL SENSORS FOR THE CASES GTF**
Hugh W. Davis (Ball Corp., Boulder, CO.) and Angelia P. Bukley *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 263-275 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

**N93-19287#** Nippon Electric Co. Ltd., Tokyo (Japan). C and C Systems Research Labs.
**EVALUATION OF FINITE ELEMENT ANALYSIS ON THE PARALLEL SIMULATION MACHINE CENJU [HEIRETSU SHIMYURESHON MASHIN SENJU JOU NO YUUGEN YOUSOHOU]**
Toshiyuki Nakata, Yasushi Kanoh, Nobuhiiko Koike, Hidehito Okumura (National Aerospace Lab., Tokyo, Japan ), Kunihiko Ohtake (National Aerospace Lab., Tokyo, Japan ), Takashi Nakamura (National Aerospace Lab., Tokyo, Japan ), and Masahiro Fukuda (National Aerospace Lab., Tokyo, Japan ) *In* NAL, Proceedings of the Ninth NAL Symposium on Aircraft Computational Aerodynamics Dec. 1991 p 83-89 In JAPANESE (For primary document see N93-19273 06-02)
Avail: CASI HC A02/MF A03

**N93-19458*#** North Carolina Agricultural and Technical State Univ., Greensboro. Controls and Guidance Group.
**DYNAMIC CHARACTERIZATION, MONITORING AND CONTROL OF ROTATING FLEXIBLE BEAM-MASS STRUCTURES VIA PIEZO-EMBEDDED TECHNIQUES**
Steven H.-Y. Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical StateUniversity 12 Dec. 1992 10 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

**N93-19459*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**A PIECEWISE CONTINUOUS TIMOSHENKO BEAM MODEL FOR THE DYNAMIC ANALYSIS OF TAPERED BEAM-LIKE STRUCTURES**
Ji Yao Shen (North Carolina Agricultural and Technical State Univ., Greensboro.), Elias G. Abu-Saba (North Carolina Agricultural and Technical State Univ., Greensboro.), William M. McGinley (North Carolina Agricultural and Technical State Univ., Greensboro.), Lonnie Sharpe, Jr. (North Carolina Agricultural and Technical State Univ., Greensboro.), and Lawrence W. Taylor, Jr. *In* North Carolina Agricultural and Technical State Univ., The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 13 p Submitted for publication (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

# 42 GEOSCIENCES (GENERAL)

**N93-18709*#** Universities Space Research Association, Greenbelt, MD.
**GODDARD VISITING SCIENTIST PROGRAM FOR THE SPACE AND EARTH SCIENCES DIRECTORATE Technical Report, 1 Apr. - 30 Jun. 1992**
Frank Kerr 1 Dec. 1992 318 p
(Contract NAS5-30442)
(NASA-TM-108588; NAS 1.15:108588) Avail: CASI HC A14/MF A03

A visiting scientist program was conducted in the space and earth sciences at GSFC. Research was performed in the following areas: astronomical observations; broadband x-ray spectral variability; ground-based spectroscopic and photometric studies; Seyfert galaxies; active galactic nuclei (AGN); massive stellar black holes; the differential microwave radiometer (DMR) onboard the cosmic background explorer (COBE); atmospheric models; and airborne and ground based radar observations. The specific research efforts are detailed by tasks. For individual titles, see N93-18710 through N93-18720.

**N93-18710*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.
**BBXRT AND GINGA OBSERVATIONS OF THE SEYFERT 1 GALAXY MRK 335 Abstract Only** **c89**
T. J. Turner, K. Nandra (Leicester Univ., England ), G. M. Madejski (Universities Space Research Association, Greenbelt, MD.), F. Marshall, R. F. Mushotzky, R. Petre, K. A. Pounds (Leicester Univ., England ), A. P. Smale, P. Serlemitsos, and K. Weaver (Maryland Univ., College Park.) et al *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

We present new X-ray observations of Mrk 335 in the 0.4-10 keV band using the broadband X-ray telescope (BBXRT) and in the 2-18 keV band with Ginga. The BBXRT data show a gradual steepening of the spectrum to softer energies. We suggest that the nuclear emission can be explained by a self-consistent pair cascade model. The Ginga data show evidence for variability in absorption, uncorrected with flux changes of the continuum source. The inconsistency between the opacity observed at the iron K edge and at softer X-ray energies implies that the absorber has an ionization state BeXV.
Author

**N93-18711*#** Cambridge Univ. (England).
**THE BROAD-BAND X RAY SPECTRAL VARIABILITY OF Mkn 841 Abstract Only** **c89**
I. M. George, K. Nandra, A. C. Fabian, T. J. Turner (National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.), C. Done (National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.), and C. S. R. Day (Tokyo Univ., Sagamihara, Japan ) *In* NASA. Goddard Space Flight Center, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

The results of a detailed spectral analysis of four X-ray observations of the luminous Seyfert 1.5 galaxy Mkn 841 performed using the EXOSAT and Ginga satellites over the period June 1984 to July 1990 are reported. Preliminary results from a short ROSAT PSPC observation of Mkn 841 in July 1990 are also presented. Variability is apparent in both the soft (0.1-1.0

keV) and medium (1-20 keV) energy bands. Above 1 keV, the spectra are adequately modelled by a power-law with a strong emission line of equivalent width approximately 450 eV. The energy of the line (approximately 6.4 keV) is indicative of K-shell fluorescence from neutral iron, leading to the interpretation that the line arises via X-ray illumination of cold material surrounding the source. In addition to the flux variability, the continuum shape also changes in a dramatic fashion, with variations in the apparent photon index Delta(Gamma) approximately 0.6. The large equivalent width of the emission line clearly indicates a strongly enhanced reflection component in the source, compared to other Seyferts observed with Ginga. The spectral changes are interpreted in terms of a variable power-law continuum superimposed on a flatter reflection component. For one Ginga observation, the reflected flux appears to dominate the medium energy X-ray emission, resulting in an unusually flat slope (Gamma approximately 1.0). The soft X-ray excess is found to be highly variable by a factor approximately 10. These variations are not correlated with the hard flux, but it seems likely that the soft component arises via reprocessing of the hard X-rays. We find no evidence for intrinsic absorption, with the equivalent hydrogen column density constrained to be less than or equal to few x 10(exp 20) cm(exp -2). The implications of these results for physical models for the emission regions in this and other X-ray bright Seyferts are briefly discussed. Author

**N93-18712*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.

**THE X RAY VARIABILITY OF NGC6814: POWER SPECTRA Abstract Only** **c89**

C. Done, G. M. Madejski, R. F. Mushotsky, T. J. Turner, K. Koyama (Nagoya Univ., Japan ), and H. Kunieda (Nagoya Univ., Japan ) *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 2 p (For primary document see N93-18709 06-42)

Avail: CASI HC A01/MF A03

Simulation techniques are used to obtain the X-ray variability power spectrum of unevenly sampled GINGA data from NGC6814. A simple power law is not an adequate description of the power spectrum, with the residuals showing excess power on timescales consistent with the periodicity seen in EXOSAT observations of this object. However the shape of the folded lightcurve is very different, with 3 main peaks, two of which are separated by an extremely sharp dip instead of the single peak and small harmonic structure observed by EXOSAT. Using the dip as a fiducial mark, a second GINGA observation of this source taken one year later is found to be consistent with being completely periodic and phase coherent with this first GINGA observation. Thus the period is consistent with being constant over a period of 6 years, but phase coherence is only maintained on timescales of approximately 1 year. Over 75 percent of the total source variability is due to the periodic component (r.m.s. amplitude of 36 percent). The residual variability can be described as the more usual 'flicker noise' f(exp -1.1) powerlaw. This shows no apparent high frequency break on timescales greater than 300 seconds. Subtle differences in the shape of the folded light curve with energy, and the very large amount of power in the periodic component suggest occultation as its origin, though amplification of variability from an X-ray emitting 'hot spot' at the disk inner radius through gravitational lensing is also possible. The former suffers from the very arbitrary nature of the periodic timescale, while the latter is unattractive as it cannot simply explain the lack of high frequency break in the residual power. That these models probably fail to provide an adequate explanation may be due to the added complexity of anisotropy of the X-ray emission, suggested by the discrepancy between the lack of soft photons implied by the flat spectrum and the copious source of soft photons available from reprocessing in the iron line producing material. Author

**N93-18713*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.

**THE X RAY VARIABILITY OF AGN AND THE ANOMALOUS BEHAVIOR OF NGC6814 Abstract Only** **c89**

C. Done, G. M. Madejski, R. F. Mushotzky, T. J. Turner, K. Koyama (Nagoya Univ., Japan ), and H. Kunieda (Nagoya Univ., Japan ) *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)

Avail: CASI HC A01/MF A03

The power spectra of the X-ray variable AGN are typically scale invariant with no characteristic timescale. The one strong exception to this is NGC6814, where the EXOSAT data showed evidence for a periodic component at 12200 plus or minus 100 seconds. The power spectra of a GINGA lightcurve from this source, found using simulation techniques to account for the uneven sampling, also cannot be well fit by a single power law. A folded light curve analysis of the GINGA data shows a strong peak in the variance, indicative of a periodic component, at 12130.9 plus or minus 0.6 seconds. A second GINGA observation of this source taken one year later is consistent with the periodicity maintaining phase coherence for 7 periods in the range of 12110-12145 seconds. Including the limits from the folding selects a period of 12130.39 plus or minus 0.05 seconds. Phase coherence is not maintained between this and the EXOSAT observations, as the structure of the folded light curves is very different. Thus the periodicity is long lived and stable, but phase coherence is only maintained on timescales of approximately 1 year. Author

**N93-18714*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.

**EVIDENCE FOR A MASSIVE STELLAR BLACK HOLE IN X RAY NOVA MUSCAE** **c89**

Wan Chen, Neil Gehrels (Universities Space Research Association, Greenbelt, MD.), and F. H. Cheng (Space Telescope Science Inst., Baltimore, MD.) *In its* Goddard Visiting Scientist Program for the Space and Earth Directorate 1 Dec. 1992 14 p (For primary document see N93-18709 06-42)

Avail: CASI HC A03/MF A03

We present evidence that the X-ray Nova Muscae system contains a massive, greater than 10 M solarmass, black hole. A recently measured photometric binary mass function gives the black hole mass for this system as a function of orbital inclination angle. From the spectral redshift and width of the positron annihilation gamma-ray line observed by GRANAT/SIGMA, we find the accretion disk inclination angle to be 22 deg plus or minus 18 deg. Assuming the accretion disk lies in the orbital plane of the system, the black hole mass is found to have a lower limit of 14 M solar mass although statistics are poor. This is supported by spectral modeling of combined optical/UV/x-ray/gamma-ray data and by a new Nova Muscae distance limit we derive of greater than 3 kpc. The large mass for this black hole and the high binary mass ratio it implies (greater than 20) raise a serious challenge to theoretical models of the formation and evolution of massive binaries. The gamma-ray line technique introduced here can give tight constraints on orbital parameters when high-sensitivity line measurements are made by such missions as GRO. Author

**N93-18715*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.

**COBE DIFFERENTIAL MICROWAVE RADIOMETER (DMR) DATA PROCESSING TECHNIQUES Abstract Only** **c89**

P. D. Jackson, G. F. Smoot (California Univ., Berkeley.), C. L. Bennett (California Univ., Berkeley.), J. Aymon, C. Backus, G. DeAmici, G. Hinshaw (Universities Space Research Association, Greenbelt, MD.), P. B. Keegstra, A. Kogut, and C. Lineweaver (California Univ., Berkeley.) et al *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)

Avail: CASI HC A01/MF A03

The purpose of the Differential Microwave Radiometer (DMR) experiment on the Cosmic Background Explorer (COBE) satellite is to make whole-sky maps, at frequencies of 31.5, 53, and 90 GHz, of any departures of the Cosmic Microwave Background (CMB) from its mean value of 2.735 K. An elaborate software system is necessary to calibrate and invert the differential measurements, so as to make sky maps free from large scale systematic errors to levels less than a millionth of the CMB. Author

**N93-18716*#** California Univ., Berkeley. Astronomy Dept.

**DAILY QUALITY ASSURANCE SOFTWARE FOR A SATELLITE RADIOMETER SYSTEM Abstract Only** **c61**

P. B. Keegstra, G. F. Smoot, C. L. Bennett, J. Aymon, C. Backus, G. DeAmici, G. Hinshaw, P. D. Jackson, A. Kogut, and C. Lineweaver et al *In* NASA. Goddard Space Flight Center, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For

primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

Six Differential Microwave Radiometers (DMR) on COBE (Cosmic Background Explorer) measure the large-angular-scale isotropy of the cosmic microwave background (CMB) at 31.5, 53, and 90 GHz. Quality assurance software analyzes the daily telemetry from the spacecraft to ensure that the instrument is operating correctly and that the data are not corrupted. Quality assurance for DMR poses challenging requirements. The data are differential, so a single bad point can affect a large region of the sky, yet the CMB isotropy requires lengthy integration times (greater than 1 year) to limit potential CMB anisotropies. Celestial sources (with the exception of the moon) are not, in general, visible in the raw differential data. A 'quicklook' software system was developed that, in addition to basic plotting and limit-checking, implements a collection of data tests as well as long-term trending. Some of the key capabilities include the following: (1) stability analysis showing how well the data RMS averages down with increased data; (2) a Fourier analysis and autocorrelation routine to plot the power spectrum and confirm the presence of the 3 mK 'cosmic' dipole signal; (3) binning of the data against basic spacecraft quantities such as orbit angle; (4) long-term trending; and (5) dipole fits to confirm the spacecraft attitude azimuth angle. Author

**N93-18717*#** California Univ., Berkeley. Dept. of Physics and Space Sciences Lab.

**A BOLOMETRIC MILLIMETER-WAVE SYSTEM FOR OBSERVATIONS OF ANISOTROPY IN THE COSMIC MICROWAVE BACKGROUND RADIATION ON MEDIUM ANGULAR SCALES Abstract Only** **c89**

M. L. Fischer, D. C. Alsop, E. S. Cheng, A. C. Clapp, D. A. Cottingham, J. O. Gundersen, T. C. Koch (California Univ., Santa Barbara.), E. Kreysa (Max-Planck-Inst. fuer Radioastronomie, Bonn, Germany ), P. R. Meinhold (California Univ., Santa Barbara.), and A. E. Lange et al *In* NASA. Goddard Space Flight Center, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

We report the performance of a bolometric system designed to measure the anisotropy of the cosmic microwave background (CMB) radiation on angular scales from 0 deg 3 min to 3 deg. The system represents a collaborative effort combining a low-background 1 m diameter balloon-borne telescope with new multimode feed optics, a beam modulation mechanism with high stability, and a four-channel bolometric receiver with passbands centered near frequencies of 3 (90), 6 (180), 9 (270), and 12 (360) cm(exp -1) (GHz). The telescope was flown three times with the bolometric receiver and has demonstrated detector noise limited performance capable of reaching sensitivity levels of Delta(T)/T(sub CMB) is approximately equal to 10(exp -5) with detectors operated at T = 0.3 K. Author

**N93-18718*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY. Lab. for Atmospheres.

**NUMERICAL EXPERIMENTS ON CONSISTENT HORIZONTAL AND VERTICAL RESOLUTION FOR ATMOSPHERIC MODELS AND OBSERVING SYSTEMS Abstract Only** **c46**

Michael S. Fox-Rabinovitz and Richard S. Lindzen (Massachusetts Inst. of Tech., Cambridge.) *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 2 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

Simple numerical experiments are performed in order to determine the effects of inconsistent combinations of horizontal and vertical resolution in both atmospheric models and observing systems. In both cases, we find that inconsistent spatial resolution is associated with enhanced noise generation. A rather fine horizontal resolution in a satellite data observing system seems to be excessive when combined with the usually available relatively coarse vertical resolution. Using different strength horizontal filters, adjusted in such a way as to render the effective horizontal resolution more consistent with vertical resolution for the observing system, may result in improvement of the analysis accuracy. However, the increase of vertical resolution for a satellite data observing system is desirable. For the conventional data observing system with better vertically resolved data, the results are different in that little or no horizontal filtering is needed to make spatial resolution more consistent for the system. The obtained experimental estimates of consistent vertical and effective horizontal resolution are in a general agreement with consistent resolution estimates previously derived theoretically by the authors. Author

**N93-18719*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY. Lab. for Atmospheres.

**DIABATIC DYNAMIC INITIALIZATION Abstract Only** **c46**

Michael S. Fox-Rabinovitz and Brian D. Gross *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 2 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

A generalized dynamical adjustment procedure was applied to a diabatic model to produce balanced initial conditions. Namely, backward adiabatic model integration is followed by forward diabatic model integration, with a high frequency (low pass) filter in the form of the Euler-backward time differencing scheme being applied throughout the whole integration. As a result of the application of such a diabatic dynamic initialization procedure within the Goddard Laboratory for Atmospheres (GLA) 4-D data assimilation system, the following properties of forecasts from initialized fields are achieved right from the beginning of the usual forecast integration: (1) the forecast tendencies (and fields) are free of any noise due to imbalance in initial conditions; (2) the shocks related to an initial imbalance between model physics and dynamics, and especially the substantial initial imbalance of precipitation and evaporation fields, or the initial spin-up effect, are practically removed. Diabatic dynamic initialization has been compared with implicit nonlinear normal mode initialization, and found to be superior in removing the initial spin-up effect, and also in improving the tropical structure. The diabatic dynamic initialization procedure was successfully tested for the GLA system with the use of all conventional data and the GLA satellite data retrievals. It allows a smooth data insertion without any shocks or imbalances, which is highly desirable for efficient functioning of 4-D data assimilation systems. The developed initialization procedure is computationally efficient and in principle easily applicable to different forecast models. Author

**N93-18720*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.

**A COMPARISON OF AIRBORNE AND GROUND-BASED RADAR OBSERVATIONS WITH RAIN GAGES DURING THE CaPE EXPERIMENT** **c47**

Makoto Satake, David A. Short, and Toshio Iguchi *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 3 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

The vicinity of KSC, where the primary ground truth site of the Tropical Rainfall Measuring Mission (TRMM) program is located, was the focal point of the Convection and Precipitation/Electrification (CaPE) experiment in Jul. and Aug. 1991. In addition to several specialized radars, local coverage was provided by the C-band (5 cm) radar at Patrick AFB. Point measurements of rain rate were provided by tipping bucket rain gage networks. Besides these ground-based activities, airborne radar measurements with X- and Ka-band nadir-looking radars on board an aircraft were also recorded. A unique combination data set of airborne radar observations with ground-based observations was obtained in the summer convective rain regime of central Florida. We present a comparison of these data intending a preliminary validation. A convective rain event was observed simultaneously by all three instrument types on the evening of 27 Jul. 1991. The high resolution aircraft radar was flown over convective cells with tops exceeding 10 km and observed reflectivities of 40 to 50 dBZ at 4 to 5 km altitude, while the low resolution surface radar observed 35 to 55 dBZ echoes and a rain gage indicated maximum surface rain rates exceeding 100 mm/hr. The height profile of reflectivity measured with the airborne radar show an attenuation of 6.5 dB/km (two way) for X-band, corresponding to a rainfall rate of 95 mm/hr. Author

# 43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

**N93-17927*#** Colorado Univ., Boulder.
**FINAL REPORT**
Joe Zamudio 12 Jan. 1993 5 p
(Grant NAGw-1293)
(NASA-CR-192091; NAS 1.26:192091) Avail: CASI HC A01/MF A01

In eastern Nevada and western Utah is an extensive terrane that has experienced a complex tectonic history of Mesozoic deformation and superposed Tertiary extension. The Mesozoic tectonic history of this area has been the subject of controversy for the past twenty or more years. The debate has centered on whether major Mesozoic geologic structures were due to compressional or extensional tectonic regimes. The goal of our research was to decipher the deformational history of the area by combining detailed geologic mapping, remote sensing data analysis, and U-Pb and K-Ar geochronology. This study area includes the Dolly Varden Mountains and adjacent Currie Hills, located in the semi-arid environment of the northeastern Great Basin in Nevada. Vegetation cover in the Dolly Varden Mountains typically ranges from about 10 percent to 50 percent, with some places along drainages and on high, north-facing slopes where vegetation cover approaches 100 percent. Sagebrush is found at less vegetated lower elevations, whereas pinon pine and juniper are prevalent above 2,000 meters. A variety of geologic materials is exposed in the study area. A sequence of Late Paleozoic and Triassic sedimentary rocks includes limestone, dolomite, chert, sandstone, siltstone and shale. A two-phase granitic stock, called the Melrose, intruded these rocks, resulting in metamorphism along the intrusive contact. Tertiary volcanic rocks cover most of the eastern part of the Dolly Varden Mountains and low-lying areas in the Currie Hills. Author

**N93-17951#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**IMAGE MATCHING STRATEGIES FOR THE CO-REGISTRATION OF CAESAR SEA-IMAGES: AN HIERARCHICAL AREA-BASED APPROACH, PART 2**
M. J. P. M. Lemmens (Technische Univ., Delft, Netherlands ) Aug. 1992 75 p
(BCRS-90-40b-Pt-2; ISBN-90-5411-036-8; ETN-93-93313) Avail: CASI HC A04/MF A01

The problem of automizing the process of coregistration of CAESAR (CCD (Charge Coupled Device) Airborne Experimental Scanner for Applications in Remote Sensing) images, using digital image matching techniques is addressed. In particular the first stage of the study on coregistration of CAESAR sea images is emphasized. This stage consists of designing and developing algorithms and strategies in order to arrive at solutions of the problem of coregistration. The design of a feasible computational experimentation environment and the design of tests strategies is treated. These strategies are hierarchical area based strategies, which are theoretically suited for the task at hand. Each strategy consists of a number of stages: preprocessing (enhancement); distinctive point selection in the target image; tracing of the corresponding points in the search image; global consistency check; post transformation. It is stressed that matching of sea images is an extremely severe problem, that is far from being solved. ESA

**N93-17953#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**INFORMATION SYSTEM FOR CO-REGISTRATION OF CAESAR SEA-IMAGES BASED ON TWO DIMENSIONAL IMAGE MATCHING TECHNIQUES (SCORE). PART 3: DESIGN AND DETAILED DESIGN DOCUMENT**
A. J. Rietveld (National Aerospace Lab., Amsterdam, Netherlands ), G. M. H. J. Habets (National Aerospace Lab., Amsterdam, Netherlands ), and W. J. Looijen (National Aerospace Lab., Amsterdam, Netherlands ) Aug. 1992 56 p
(BCRS-90-40c-Pt-3; ISBN-90-5411-045-7; ETN-93-93314) Avail: CASI HC A04/MF A01

The functional design and parts of the detailed design of the information system for coregistration of two dimensional images (SCORE) that is used to investigate the matchability of two CAESAR (CCD (Charge Coupled Device) Airborne Experimental Scanner for Applications in Remote Sensing) sea images by means of their internal image characteristics are presented. CAESAR is a multispectral push broom scanner designed for land and sea (water) observation in up to nine spectral bands. CAESAR sea mode images are recorded under a different view angle and at different time intervals. It was concluded from the CAESAR evaluation phase that sea mode images cannot be coregistrated to each other with sufficient accuracy using inertial navigation system data. Two dimensional image matching techniques were examined on their feasibility for coregistration resulting in the SCORE information system pilot version. ESA

**N93-17965#** Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
**A PLAN FOR DEVELOPING A HIERARCHAL THREE-DIMENSIONAL LANDSCAPE SIGNATURE MODEL Final Report**
Randy K. Scoggins and Lee K. Balick (EG and G Energy Measurements, Inc., Las Vegas, NV.) Sep. 1992 30 p
(AD-A257550; WES/MP/EL-92-10) Avail: CASI HC A03/MF A01

This paper describes an approach for developing a three-dimensional (3D) landscape signature computer model. Primary focus is on thermal image generation using material temperature models and environment models for energy budget calculations. Current landscape signature models utilize one-dimensional conduction-calculations and constant meteorological data over large terrain areas. The model described here would compute thermal and other signatures using advanced 3D techniques where necessary to simulate higher resolution details necessary for such applications as sensor system evaluation. GRA

**N93-17979*#** Colorado Univ., Boulder. Center for the Study of Earth from Space.
**ARTIFICIAL INTELLIGENCE FOR GEOLOGIC MAPPING WITH IMAGING SPECTROMETERS Final Report**
F. A. Kruse 29 Jan. 1993 70 p
(Grant NAGw-1601)
(NASA-CR-192086; NAS 1.26:192086) Avail: CASI HC A04/MF A01

This project was a three year study at the Center for the Study of Earth from Space (CSES) within the Cooperative Institute for Research in Environmental Science (CIRES) at the University of Colorado, Boulder. The goal of this research was to develop an expert system to allow automated identification of geologic materials based on their spectral characteristics in imaging spectrometer data such as the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS). This requirement was dictated by the volume of data produced by imaging spectrometers, which prohibits manual analysis. The research described is based on the development of automated techniques for analysis of imaging spectrometer data that emulate the analytical processes used by a human observer. The research tested the feasibility of such an approach, implemented an operational system, and tested the validity of the results for selected imaging spectrometer data sets. Author

**N93-18070*#** Universities Space Research Association, Greenbelt, MD.
**GODDARD VISITING SCIENTIST PROGRAM FOR THE SPACE AND EARTH SCIENCES DIRECTORATE Technical Report, 1 Jul. - 30 Sep. 1992**
Frank Kerr 10 Dec. 1992 245 p
(Contract NAS5-30442)
(NASA-TM-108590; NAS 1.15:108590) Avail: CASI HC A11/MF A03

Progress reports of the Visiting Scientist Program covering the period from 1 Jul. - 30 Sep. 1992 are included. Topics covered include space science and earth science. Other topics covered include cosmic rays, magnetic clouds, solar wind, satellite data, high resolution radiometer, and microwave scattering. For individual titles, see N93-18071 through N93-18074.

**N93-18071*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD. Lab. for High Energy Astrophysics.
**COSMIC RAY DECREASES AND MAGNETIC CLOUDS** **c93**
H. V. Cane *In* Universities Space Research Association, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 10 Dec. 1992 12 p (For primary document see N93-18070 06-43)
Avail: CASI HC A03/MF A03

Energetic particle data, obtained from IMP 8, in conjunction with solar

wind field and plasma data at the times of reported magnetic clouds was studied. It is shown that magnetic clouds can cause a depression of the cosmic ray flux but high fields are required. A depression of 3 percent in a neutron monitor requires a field of about 25 nT. Such high fields are found only in a subset of coronal ejecta. The principal cause for Forbush decreases associated with energetic shocks is probably turbulence in the post-shock region although some shocks will be followed by an ejecta with a high field. Each event is different. The lower energy particles can help in identifying the dominant processes in individual events. Author

**N93-18072*#** Tasmania Univ., Hobart (Australia). Physics Dept.
**THE SOLAR WIND STRUCTURES ASSOCIATED WITH COSMIC RAY DECREASES AND PARTICLE ACCELERATION IN 1978-1982 c92**
H. V. Cane, I. G. Richardson (Maryland Univ., College Park.), and T. T. VonRosenvinge (Maryland Univ., College Park.) *In* Universities Space Research Association, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 10 Dec. 1992 26 p (For primary document see N93-18070 06-43)
Avail: CASI HC A03/MF A03

The time histories of particles in the energy range 1 MeV to 1 GeV at times of all greater than 3 percent cosmic ray decreases in the years 1978 to 1982 are studied. Essentially all 59 of the decreases commenced at or before the passages of interplanetary shocks, the majority of which accelerated energetic particles. We use the intensity-time profiles of the energetic particles to separate the cosmic ray decreases into four classes which we subsequently associate with four types of solar wind structures. Decreases in class 1 (15 events) and class 2 (26 events) can be associated with shocks which are driven by energetic coronal mass ejections. For class 1 events the ejecta is detected at 1 AU whereas this is not the case for class 2 events. The shock must therefore play a dominant role in producing the depression of cosmic rays in class 2 events. In all class 1 and 2 events (which comprise 69 percent of the total) the departure time of the ejection from the sun (and hence the location) can be determined from the rapid onset of energetic particles several days before the shock passage at Earth. The class 1 events originate from within 50 deg of central meridian. Class 3 events (10 decreases) can be attributed to less energetic ejections which are directed towards the Earth. In these events the ejecta is more important than the shock in causing a depression in the cosmic ray intensity. The remaining events (14 percent of the total) can be attributed to corotating streams which have ejecta material embedded in them. Author

**N93-18073*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**LINEAR MIXING MODEL APPLIED TO COARSE RESOLUTION SATELLITE DATA**
Brent N. Holben and Yosio E. Shimabukuro (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil ) *In* Universities Space Research Association, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 10 Dec. 1992 21 p (For primary document see N93-18070 06-43)
Avail: CASI HC A03/MF A03

A linear mixing model typically applied to high resolution data such as Airborne Visible/Infrared Imaging Spectrometer, Thematic Mapper, and Multispectral Scanner System is applied to the NOAA Advanced Very High Resolution Radiometer coarse resolution satellite data. The reflective portion extracted from the middle IR channel 3 (3.55 - 3.93 microns) is used with channels 1 (0.58 - 0.68 microns) and 2 (0.725 - 1.1 microns) to run the Constrained Least Squares model to generate fraction images for an area in the west central region of Brazil. The derived fraction images are compared with an unsupervised classification and the fraction images derived from Landsat TM data acquired in the same day. In addition, the relationship betweeen these fraction images and the well known NDVI images are presented. The results show the great potential of the unmixing techniques for applying to coarse resolution data for global studies. Author

**N93-18074*#** Texas Univ., Arlington. Wave Scattering Research Center.
**A MICROWAVE SCATTERING MODEL FOR LAYERED VEGETATION**
Mostafa A. Karam, Adrian K. Fung, Roger H. Lang (George Washington Univ. Medical Center, Washington, DC.), and Narinder S. Chauhan (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.) *In* Universities Space Research Association, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 10 Dec. 1992 18 p (For primary document see N93-18070 06-43)
(Grants NAGw-2344; NAGw-2071)
Avail: CASI HC A03/MF A03

A microwave scattering model was developed for layered vegetation based on an iterative solution of the radiative transfer equation up to the second order to account for multiple scattering within the canopy and between the ground and the canopy. The model is designed to operate over a wide frequency range for both deciduous and coniferous forest and to account for the branch size distribution, leaf orientation distribution, and branch orientation distribution for each size. The canopy is modeled as a two-layered medium above a rough interface. The upper layer is the crown containing leaves, stems, and branches. The lower layer is the trunk region modeled as randomly positioned cylinders with a preferred orientation distribution above an irregular soil surface. Comparisons of this model with measurements from deciduous and coniferous forests show good agreements at several frequencies for both like and cross polarizations. Major features of the model needed to realize the agreement include allowance for: (1) branch size distribution, (2) second-order effects, and (3) tree component models valid over a wide range of frequencies. Author

**N93-18213#** Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
**TERRAIN BACKGROUND SIGNATURE RESEARCH Final Report**
Richard A. Weiss, Randy K. Scoggins, and David L. Meeker Sep. 1992 96 p
(AD-A257917; WES/TR/EL-92-32) Avail: CASI HC A05/MF A01

This report presents a summary of the multispectral terrain background signature models and battlefield aids that have been developed at the U.S. Army Engineer Waterways Experiment Station as part of a target reconnaissance and surveillance program and as part of a camouflage improvement and evaluation program. A thermal infrared signature model for rough terrain is presented which calculates the surface brightness temperature in terms of local weather conditions, type of terrain texture, thermodynamic parameters of the soil and vegetation, and the root-mean-square height and correlation length of the rough terrain surface. Radar wave and laser light-scattering models have been developed for rough terrain surfaces. These models predict the scattering cross section, bidirectional reflectance, and depolarizability for realistic terrain surfaces in terms of surface roughness parameters, average dielectric constant, and the root-mean-square and correlation length of the random dielectric medium that is used to model the volume scattering from terrain backgrounds. The predicted background signatures are used to develop battlefield aids that include the Regional Thermal Radiance Map, the Regional Radar Scattering Map, and the Regional Laser Reflectance Map, which use color codes to display the thermal and electromagnetic characteristics of potential battlefield areas. Finally, an infrared scene generator is developed which creates a synthetic infrared image of a target located in a three-dimensional terrain background. GRA

**N93-18216#** Naval Postgraduate School, Monterey, CA.
**MULTISPECTRAL IMAGERY: AN ESSENTIAL TOOL FOR TODAY'S NAVAL OPERATIONS M.S. Thesis**
Diane E. Burgess Sep. 1992 106 p
(AD-A257957) Avail: CASI HC A06/MF A02

This thesis examines the essential use of Multispectral Imagery (MSI) land remote sensing data in support of future military operations, specifically naval operations. The importance of proper management of the Landsat program and funding are discussed in depth. Results of surveys from naval intelligence specialists and operators express the interest of tile Fleet in the need for MSI for future military operations. To continue its lead in remote sensing systems, the U.S. must consider foreign competition, such as that from the French Spot system. Examination of this competition, how the U.S. will cope with it, and planning implications from the spread of MSI capabilities are discussed. Recommendations for the future of the Landsat program and MSI are listed. GRA

**N93-18230*#** Analytics, Inc., Willow Grove, PA.
**HOLOGRAPHIC ENHANCED REMOTE SENSING SYSTEM Final Technical Report No. 2168**
Helene P. Iavecchia, Edwin S. Gaynor, Lloyd Huff, William T. Rhodes, and

Edward H. Rothenheber Aug. 1990 272 p
(Contract NAS7-1036)
(NASA-CR-190867; NAS 1.26:190867) Avail: CASI HC A12/MF A03

The Holographic Enhanced Remote Sensing System (HERSS) consists of three primary subsystems: (1) an Image Acquisition System (IAS); (2) a Digital Image Processing System (DIPS); and (3) a Holographic Generation System (HGS) which multiply exposes a thermoplastic recording medium with sequential 2-D depth slices that are displayed on a Spatial Light Modulator (SLM). Full-parallax holograms were successfully generated by superimposing SLM images onto the thermoplastic and photopolymer. An improved HGS configuration utilizes the phase conjugate recording configuration, the 3-SLM-stacking technique, and the photopolymer. The holographic volume size is currently limited to the physical size of the SLM. A larger-format SLM is necessary to meet the desired 6 inch holographic volume. A photopolymer with an increased photospeed is required to ultimately meet a display update rate of less than 30 seconds. It is projected that the latter two technology developments will occur in the near future. While the IAS and DIPS subsystems were unable to meet NASA goals, an alternative technology is now available to perform the IAS/DIPS functions. Specifically, a laser range scanner can be utilized to build the HGS numerical database of the objects at the remote work site. Author

**N93-18232*#** Wisconsin Univ., Madison. Dept. of Soil Science.
**MODELING ENERGY AND MASS FLUXES FROM PRAIRIE CANOPIES Annual Research Report, 1 Mar. - 31 Aug. 1992**
John M. Norman 31 Aug. 1992 7 p
(Grant NAG5-1416)
(NASA-CR-191801; NAS 1.26:191801) Avail: CASI HC A02/MF A01

The main emphasis of this research project is on partitioning of mass and energy fluxes between vegetation and soil at the FIFE site, preparation of data from the FIFE Information System for an international thermal data set comparison, and studying the relation between surface temperatures observed from satellites and in situ measurements of surface temperature. Author

**N93-18346#** Army Topographic Engineering Center, Fort Belvoir, VA.
**MANIPULATION OF LANDSAT SPECTRAL CHARACTERISTICS TO CLASSIFY VEGETATION AND SOIL WETNESS IN THE RAINFOREST OF BOLIVIA**
Michael G. Barwick and Harry B. Puffenberger 9 Nov. 1992 13 p
(AD-A257847; TEC-R-191) Avail: CASI HC A03/MF A01

This study attempts to classify tropical region soils and vegetation by moisture content from multispectral imagery. Identified wet areas were used to determine the percentage of wetness in the study area, by evaluating the spectral response of tropical rainforest vegetation and soils. Supervised classification, unsupervised classification, and manipulation of spectral band techniques were used to determine percentages of wetness in the study area. Using these methodologies, vegetation and soil units associated with wet conditions were classified. Soil types were categorized into the following: (1) areas that are moist; (2) forested areas that are moist or wet depending upon the season; and (3) forested/swamp/land subject to inundation, areas that are wet a good portion of the year. Vegetation was classified into the following: (1) marsh; (2) tropical swamp forest; and (3) tropical moist forest. Results demonstrate that digital spectral data from Landsat imagery can be used to locate and evaluate varying degrees of wetness in soils and different vegetation types associated with wet conditions. GRA

**N93-18431#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**MICROWAVE REMOTE SENSING FOR FOREST MONITORING PURPOSES**
J. J. vanderSanden (Wageningen Agricultural Univ., Netherlands ) Apr. 1992 43 p
(BCRS Proj. OP-2.17)
(BCRS-91-15; ISBN-90-5411-042-2; ETN-92-92839) Avail: CASI HC A03/MF A01

The capacities of imaging short wave radar systems for forest monitoring studies were evaluated and a method for the analysis of a time series of radar images was developed. A multitemporal set of X and C band airborne radar data, from a deciduous forest site, was available for the purpose of the study. Topographic information was used in conjunction with the radar images in order to facilitate the extraction of radar data for individual forest stands. In X as well as C band the overall range of stand-averaged backscatter values was in the order of a few dB. The backscatter values appeared to be primarily dependent on incidence angle and species. In addition there is evidence of a relationship between backscatter and crown coverage. Stands with a relatively low degree of crown closure, for example recently thinned stands, and young stands, showed a decreased radar backscatter. ESA

**N93-18571*#** Colorado Univ., Boulder. Cooperative Inst. for Research and Environmental Sciences.
**SEA ICE - ATMOSPHERE INTERACTION: APPLICATION OF MULTISPECTRAL SATELLITE DATA IN POLAR SURFACE ENERGY FLUX ESTIMATES Semiannual Progress Report**
Konrad Steffen, A. Schweiger, J. Maslanik, J. Key, M. Haefliger, and R. Weaver Mar. 1991 16 p
(Grant NAGw-2158)
(NASA-CR-192129; NAS 1.26:192129) Avail: CASI HC A03/MF A01

In the past six months, work has continued on energy flux sensitivity studies, ice surface temperature retrievals, corrections to Advanced Very High Resolution Radiometer (AVHRR) thermal infrared data, modelling of cloud fraction retrievals, and radiation climatologies. We tentatively conclude that the SSM/I may not provide accurate enough estimates of ice concentration and type to improve our shorter term energy flux estimates. SSM/I derived parameters may still be applicable in longer term climatological flux characterizations. We hold promise for a system coupling observation to a ice deformation model. Such a model may provide information on ice distribution which can be used in energy flux calculations. Considerable variation was found in modelled energy flux estimates when bulk transfer coefficients are modulated by lead fetch. It is still unclear what the optimum formulation is and this will be the subject of further work. Data sets for ice surface temperature retrievals were assembled and preliminary data analysis was started. Finally, construction of a conceptual framework for further modelling of the Arctic radiation flux climatology was started. Author

**N93-18761#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**ANALYSIS OF THE RELATIONSHIP BETWEEN AVHRR/NOAA AND TM/LANDSAT DATA IN EVALUATING ANTHROPISM IN THE FOREST/SAVANNA TRANSITION REGION [ANALISE RELACIONAL DE DADOS AVHRR/NOAA E TM/LANDSAT NA AVALIACAO DO ANTROPISMO EM REGIAO DE CONTATO FLORESTA/SAVANA]**
Joao Roberto dosSantos, David Chung Liang Lee, and Yosio Edemir Shimabukuro Aug. 1991 14 p In PORTUGESE
(INPE-5325-PRE/1723) Avail: CASI HC A03/MF A01

Research of remote sensing applied to vegetation studies in Brazil have been directed to develop approaches using data from AVHRR (Advanced Very High Resolution Radiometer)/NOAA. In the Brazilian regional case, it has been necessary to develop methodologies of extracting information from AVHRR data, especially those for estimating deforested areas in the Amazon region. The objective of this work is to verify the relationship between the AVHRR/NOAA and Thematic Mapper (TM)/LANDSAT data in the estimation process and the knowledge of spatial distribution of anthropism in the transition region of forest/savanna. The study areas selected are between the coordinates of 51 deg 00 min to 54 deg 00 min W and 11 deg 00 min to 14 deg 00 min S, in the central-west part of Mato Grosso state. The percent values of the area occupied by the 'anthropic action' class obtained from the AVHRR classified image, provided by UNEP-GRID Project, were compared to the TM data, using linear regression analysis. In the same time, an evaluation of forest and savanna limits obtained from this two sensors was also executed. The results show: the significant relation in the anthropic areas identified by AVHRR in comparison to TM; the magnitude of estimated error through the regression model; the differentiation level of forest/savanna limits. Such research has demonstrated the use of multisensor approach, improving the methodological procedures for extracting information from orbital level, is necessary to help the knowledge and monitoring the spatial-temporal dynamic of the vegetation cover in the Amazon region. Author

**N93-19641#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**EVALUATION OF THE CURRENT STATUS OF THE MULTISENSOR APPROACH TO MONITORING VEGETATION OF BRAZIL [AVALIACAO CONJUNTURAL DE TECNICA DE ABORDAGEM MULTISENSOR PARA O MONITORAMENTO DA VEGETACAO DO BRASIL]**

Yosio Edemir Shimabukuro, Joao Roberto dosSantos, Pedro HernandezFilho, and David Chung Liang Lee Aug. 1991 12 p In PORTUGESE

(INPE-5328-PRE/1724) Avail: CASI HC A03/MF A01

A research history has shown the application of satellite data for studying vegetation cover, primarily in a regional level, using MSS (Multispectral Scanner System) and TM (Thematic Mapper)/LANDSAT and more recently HRV (High Resolution Visible)/SPOT data. Currently, there are several data collection platforms with sensors of different spatial, spectral, and temporal characteristics. This makes it necessary to improve methodologies of information extraction and their integration for monitoring vegetation cover. The AVHRR/NOAA, for instance, having much less spatial detail than LANDSAT sensors, but providing daily worldwide data collection, shows the great potential for dynamically monitoring global vegetation and land use. On the other hand, data provided by LANDSAT and SPOT sensors have been used for more detailed studies and therefore, they can be considered for calibrating the information extracted from the coarse resolution images. Hence, the objective of this research is to present an analysis of the current status of the multisensor approach techniques (AVHRR/NOAA, MSS and TM/LANDSAT, and HRV/SPOT) for monitoring vegetation of Brazil. The results of the analyzed procedures have shown the potential of multisensors for mapping, estimation of biomass, and phenology conditions of the vegetation and the human impact on the environment (deforestation, biomass burning, etc.). Author

**N93-19645#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**A METHOD FOR ESTIMATING THE PHYTOMASS OF A TROPICAL FOREST REGION THROUGH THE USE OF ORBITAL DATA [METODOLOGIA PARA ESTIMATIVA DE FITOMASSA EM REGIAO DE FLORESTA TROPICAL COM USO DE DADOS ORBITAIS]**

Newton Jordao Zerbini and Joao Roberto dosSantos Sep. 1991 9 p In PORTUGESE

(INPE-5320-PRE/1717) Avail: CASI HC A02/MF A01

The rational management of natural resources in tropical regions requires the implementation of a data collection system allowing the development of regular inventories. Among these systems, the remote sensing techniques, mainly those using orbital data, present a confirmed level of efficiency for monitoring, inventory, and management of forested areas. A method to quantify the aerial phytomass of tropical forest by means of spectral data obtained from TM-LANDSAT and HRV-SPOT is presented. The first step consists of collecting field data of all physiognomies, previously identified in a forest mapping. After that the spectral values are obtained from satellite images and they are correlated with the field data. Finally, regression analysis is used to quantify the phytomass. Computer systems 'Sistema Interativo de Tratamento de Imagens' - SITIM and 'Sistema Geografico de Informacoes' - SGI are used for data processing and to map aerial phytomass. The methodology was tested with the data from an area that will be flooded by the Hydroelectric Power Plant Porteira, in Trombetas river, Para state - Brazil. Author

**N93-19646#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**ANALYSIS OF VEGETATION INDICES OBTAINED FROM LANDSAT/TM AND SPOT/XS DATA [ANALISE DE INDICES DE VEGETACAO OBTIDOS DE DADOS DO LANDSAT/TM E DO SPOT/XS]**

Mauricio Alves Moreira and Regina Pillis Nitzche Aug. 1991 12 p In PORTUGESE

(INPE-5327-PRE/1725) Avail: CASI HC A03/MF A01

The objective of this work was to evaluate vegetation indices (simple ratio, normalized difference and transformed vegetation index) obtained on soybean and corn crops, from LANDSAT/TM and SPOT/XS data (acquired on Feb. 01, 1989). The study area is located in the southeast of Distrito Federal-Brazil. The vegetation indices were obtained from averaged values of digital numbers from 20 units (3.6 ha each one) sampled on the studied crops. The results were analyzed across correlation method for equal indices but proceeding from different sensor systems. According this research, it was concluded that the same vegetation indices were highly correlated both for soybean and corn crops and both for LANDSAT/TM and SPOT/XS, and that the lowest observed correlation (0.72) was over the soybean crop for the transformed vegetation index. Author

**N93-19737#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**ON THE COMPUTATION OF CARBON AND WATER CYCLES IN FOREST ECOSYSTEMS USING A BIOGEOCHEMICAL MODEL AND REMOTELY SENSED DATA [PERSPECTIVAS DE ESTIMATIVA DOS BALANCOS ANUAIS HIDRICO E DE CARBONO EM ECOSSISTEMAS FLORESTAIS A PARTIR DE UM MODELO BIOGEOQUIMICO FLORESTAL ASSOCIADO A TECNICAS DE SENSORIAMENTO REMOTO ORBITAL]**

Marcelo deAvilaChaves Jul. 1992 158 p In PORTUGESE

(INPE-5443-TDI/489) Avail: CASI HC A08/MF A02

This work is intended to test and evaluate how well a regional biogeochemical model is able to represent the major processes of the hydrologic and carbon cycles of forest ecosystems of conifers, growing in three different climatic areas in Brazil. The model, named 'Forecos' uses the Leaf Area Index (LAI) as the main input variable. LAI is generally accepted as being the most important variable characterizing the exchange of energy and mass in forest ecosystems. There is substantial work done showing that LAI can be estimated from remotely sensed data on the basis of the correlation that exists between this vegetation structure parameter and vegetation index obtained by manipulation of data in different spectral bands of optical sensors. Simulations of LAI of the real world and sensitivity analysis on some critical parameters were used to test the suitability of the model to represent the processes modeled. By the means of digital image classification, patterns of vegetation indexes were identified that should correspond to variations on LAI values, although absolute numbers could not be obtained at this step. The results have demonstrated that the model was able to show the relative differences for both hydrologic and carbon cycles for the three test sites studied. Besides that, the model was also capable of describing quantitatively the interactions between climatic parameters and biophysical processes in the ecosystems selected. Nevertheless, the mathematical formulation of some processes has to be revised or adjusted through fitting techniques. Finally, a validation should be achieved with measurements of state variables and some independent measurements of net primary production and hydrologic variables. The results obtained from digital classification suggest that LAI values are homogeneous in all test sites. Then, the use of a unique regional value within the realized simulations is felt to be valid. Transl. by FLS

**N93-19739#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**UPDATING TOPOGRAPHIC MAPS USING ORBITAL IMAGES IN A MICROCOMPUTER ENVIRONMENT [ACTUALIZACION DE CARTAS TOPOGRAFICAS USANDO IMAGENES ORBITALES EN UN AMBIENTE DE MICROCOMPUTADORAS]**

Oscar Ricardo Vergara, Alejandro Contreras Frau, and Julia Cesar Lima dAlge Jul. 1992 11 p In PORTUGESE

(INPE-5409-PRE/1756) Avail: CASI HC A03/MF A01

The problem of obsolescence of topographic maps is frequently aggravated by rapidity of changes due to development of some regions, with respect to the slowness of traditional updating procedures based on the use of aerial photographs. Therefore, it is of interest to study working methods which will shorten the time necessary to generate an updated map, without prejudice to its geometric precision. In this study, we conducted a practical application of a topographic map updating method which incorporates TM-LANDSAT digital imagery interpretation and makes use of the advantages offered by SITIM-SIG/INPE (The Geographic Information Image Treatment System developed in the Brazilian National Space Research Institute). Transl. by FLS

**N93-19788#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**A SYSTEM FOR SEGMENTATION AND CLASSIFICATION OF SATELLITE IMAGES [UM SISTEMA DE SEGMENTACAO E CLASSIFICACAO DE IMAGENS DE SATELITE]**

Guaraci Jose Erthal, Leila Maria Garcia Fonseca, Leonardo SantAnnaBins,

Flavio Roberto diasVelasco, and Antonio Miguel Vieir Monteiro Oct. 1991 8 p In PORTUGESE
(INPE-5291-PRE/1696) Avail: CASI HC A02/MF A01

This paper presents the design of a segmentation and classification system for satellite image under development at INPE. One would expect that this system could overcome the limitations of the traditional approach for image analysis (per point statistical image classification).

Transl. by FLS

**N93-19789#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**SOME INTERPRETATIONS ON THE GEOLOGICAL EVOLUTION IN THE SOUTHEASTERN REGION OF THE STATE OF MINAS GERAIS (BRAZIL), BASED ON REMOTE SENSING IMAGERY AND GRAVIMETRIC DATA [ALGUMAS INTERPRETACOES SOBRE A EVOLUCAO GEOLOGICA DE PARTE DO SUDESTE DO ESTADO DE MINAS GERAIS (BRASIL), COM BASE EM IMAGENS DE SENSORIAMENTO REMOTO E DADOS GRAVIMETRICOS]**

Athos Ribeiro dosSantos Aug. 1991 16 p In PORTUGESE
(INPE-5321-PRE/1718) Avail: CASI HC A03/MF A01

This paper discusses some interpretations about fault tectonics and geologic evolution in the southeastern part of Minas Gerais based on the small scale remote sensing products and gravimetric data. This area is composed of Archean to upper Proterozoic metamorphic rocks which exhibit a complex policiclic evolution. An important productive mineral province is situated in this region. This study reveals several ancient crustal discontinuities which had a fundamental role of structural control during the geologic evolution of this region. These deep crustal discontinuities may give a clue for deducing the different types of the fault movements and their relative ages.

Transl. by FLS

**N93-19790#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**MULTIPLE STUDY INVENTORY METHOD FOR TROPICAL FOREST [METODOLOGIA DE INVENTARIO MULTIESTAGIO PARA FLORESTA TROPICAL]**

Pedro Hernandezfilho, Yosio Edemir Shimabukuro, and David Chung Liang Lee Aug. 1991 16 p In PORTUGESE
(INPE-5319-PRE/1716) Avail: CASI HC A03/MF A01

This paper presents a proposed method for inventorying the regional forest, based on the study of multiple data collection at the orbital, aerial, and field levels. Reference and recommendations are made to adaptation of this model to the Tapajos National Forest, located in the state of Para, Brazil. The conceptual approach and mathematical formulation necessary for implementation of this method are presented. How to define units to be sampled from analysis of data obtained by satellite, aircraft, and in the field is discussed. Comments are made with regard to the efficiency and precision required of this tropical forest inventory model at the regional level.

Transl. by FLS

**N93-19792#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**DISCUSSION OF SOME ASPECTS OF THE RELATIONSHIP BETWEEN THE AGRONOMIC AND SPECTRAL VARIABLES OF THE COFFEE PLANTATIONS [ABORDAGEM SOBRE ALGUNS ASPECTOS DA RELACAO ENTRE PARAMETROS CULTURAIS DO CAFE E A RESPOSTA ESPECTRAL DO DOSSEL CAFEEIRO]**

Luiz Leonardi, Jose Carlos Neves Epiphanio, and Antonio Roberto Formaggio Aug. 1991 14 p In PORTUGESE
(INPE-5324-PRE/1722) Avail: CASI HC A03/MF A01

This paper describes the relationships between spectral variables (reflective TM/Landsat-5 bands) and coffee agronomic variables (vegetative vigour, age, substrate conditions, soil cover, topographic conditions, and soil type). A correlation analysis was performed for agronomic variables only, and then the correlation between TM bands and agronomic variables was analyzed. Coffee culture characteristic aspects, like row spacing, height, volume of green leaves, and their influence on coffee spectral behavior are discussed.

Transl. by FLS

**N93-19821#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**NOAA-AVHRR DATA FOR MONITORING OF GROUND VEGETATION COVER IN THE AMAZON REGION [DADOS AVHRR-NOAA PARA MONITORAMENTO DA COBERTURA VEGETAL DA REGIAO AMAZONICA]**

Sherry Chou Chen and Yosio Edemir Shimabukuro Sep. 1991 11 p In PORTUGESE
(INPE-5330-PRE/1728) Avail: CASI HC A03/MF A01

NOAA-AVHRR data with 1.1 km resolution were used to evaluate their applications for vegetation monitoring study in the Amazon region. Study results showed that, for visual interpretation, channel 3 was the best individual channel to discriminate forest, non-forest and deforested area. Channel 1 was good to detect smoke plume while channels 4 and 5 were efficient to detect cloud especially cirrus. For digital classification the tri-dimensionality of pattern space was verified. Forest or non-forest classification was carried out using box and maximum-likelihood classifiers, however, neither approach provided reliable statistics due to certain misclassifications. At the moment, it is suggested to use visual interpretation of AVHRR channel 3 imagery, at the first stage, to detect deforestation. Once the alteration has been detected, its area should be quantified using high spatial resolution satellite data to update the total statistics derived by the photo-interpretation of TM data.

Author

**N93-19822#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**EFFECT OF THE CONCENTRATION OF TWO TYPES OF SEDIMENT ON WATER COLORIMETRY AND REFLECTANCE [EFEITO DA CONCENTRACAO DE DOIS TIPOS DE SEDIMENTO EM SUSPENSAO SOBRE A COLORIMETRIA E REFLECTANCIA DA AGUA]**

R. B. deSouza, I. M. Felix, J. E. Mantovani, and E. M. L. M. Novo Sep. 1991 13 p In PORTUGESE
(INPE-5331-PRE/1729) Avail: CASI HC A03/MF A01

A laboratory study was made to assess the effect of suspended sediment concentrations on water colorimetry and reflectance. Two kinds of sediment were used, each with similar silt and clay proportions. These sediments originated from TE (Terra Roxa Estruturada) and PV (Podzolico Vermelho-Amarelo) soils. The suspensions were prepared by mixing known amounts of sediment into a filled 825 liter experimental tank. The concentrations varied from 0 to 80 mg/l for PV sediment and from 0 to 160 mg/l for TE sediment. Measurements of the water spectral reflectance in the 370-900 nm interval were made by using a SPECTRON SE-590 spectroradiometer, and a 1000 W lamp. Colorimetric classifications were made using the CIE (Commission Internacional d'Eclairage) method. The results show that the water reflectance was greater in the TE suspensions for all concentrations. The peaks of maximum reflectance for TE suspensions were also displaced toward the red portion of the spectrum. This spectral shift was also observed in the results of the colorimetric classifications. The color and the reflectance of different sediments suspended in water may play an important role in the relationships between sediment concentrations and corresponding color differences measured by satellite sensors.

Author

**N93-19834#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**A KNOWLEDGE-BASED SYSTEM FOR SATELLITE IMAGERY SEGMENTATION [UM SISTEMA DE SEGMENTACAO BASEADO EM CONHECIMENTO PARA IMAGENS DE SATELITE]**

Leila Maria Garcia Fonseca, Leonardo SantAnna Bins, Flavio Roberto Dias Velasco, and Antonio Miguel Vieir Monteiro Oct. 1991 7 p In PORTUGESE
(INPE-5296-PRE/1701) Avail: CASI HC A02/MF A01

The design of a knowledge based system for satellite image segmentation under development at the Instituto de Pesquisas Espaciais is presented. In this system, the segmentation comprehends two phases. In the first phase, regions of interest are extracted together with their properties. The second phase aims to refine the first segmentation result by using the feature set of the regions and a set of decision rules. The system was tested in images of agricultural areas obtained using the Spot sensor. The results were considered to be superior than those obtained using region growing segmenters.

Author

**N93-19842#** General Accounting Office, Washington, DC. Information Management and Technology Div.

**EARTH OBSERVING SYSTEM: INFORMATION ON NASA'S SELECTION OF DATA CENTERS. REPORT TO THE CHAIRMAN, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, HOUSE OF REPRESENTATIVES**

18 Sep. 1991 20 p

(GAO/IMTEC-91-67; B-245033) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

In June 1991, the House Committee on Science, Space, and Technology requested that we provide information about NASA's selection of the seven EOSDIS Distributed Active Archive Centers (DAAC's). To do this we interviewed the EOS program managers involved in making the selections and reviewed related program documentation. We interviewed the managers of the DAAC's at Goddard Space Flight Center, Earth Resources Observations System Data Center, and Marshall Space Flight Center about the capabilities they have in place and their future plans. We also interviewed officials at NOAA's National Oceanographic Data Center and National Environmental Satellite Data and Information Service. We obtained copies of draft self-assessments of capabilities at each of the DAAC's and estimates of data-processing volumes expected during the EOS era. We did not independently assess NASA's specific selections for DAAC's, nor did we evaluate sites that were not chosen as DAAC's. We also did not assess the appropriateness of choosing a seven-DAAC configuration. Author

**N93-19857#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**ANALYSIS OF LANDSAT/TM AND SPOT/XS DATA THROUGH VEGETATION INDICES, PHASE 2 [ANALISE DE DADOS DO LANDSAT/TM E DO SPOT/XS ATRAVES DE INDICES DE VEGETACAO, FASE II]**

Mauricio Alves Moreira Sep. 1992 28 p In PORTUGESE

(INPE-5450-RPQ/663) Avail: CASI HC A03/MF A01

The studies to evaluate vegetation indices (Simple Ratio-SR, Normalized Difference-ND, and Transformed Vegetation Index-TVI) obtained on soybean and corn crops, from LANDSAT/TM and SPOT/XS data (acquired on 1 Feb. 1989) was continued. The study area is situated in the southeast of Distrito Federal-Brazil. The vegetation indices were obtained both from digital numbers and apparent reflectance factor from 20 units (3.6 ha each one) sampled from the studied crops. The statistic analyses employed to evaluate the results obtained were the correlation method and 't' test for paired observations. It was concluded that: (1) the apparent reflectance factor obtained from SPOT/XS data are different from the apparent reflectance factor obtained from LANDSAT/TM data; (2) the same vegetation indices were highly correlated both for soybean and corn crops, and LANDSAT/TM and SPOT/XS, except the TVI obtained from data with correction for the atmospheric effects; and (3) in spite of the high correlation the vegetation indices obtained from different satellites data, they are statistically different for 5 percent level of probability. Author

**N93-19871#** Technical Research Centre of Finland, Espoo. Instrument Lab.

**AIRBORNE REMOTE SENSING [KAUKOKARTOITUS LENTOKONEESTA]**

Tuomas Hame, ed. and Mikael Holm, ed. 1991 84 p In ENGLISH and FINNISH Symposium held in Espoo, Finland, 3 Oct. 1991

(VTT-Symposium-127; ISBN-951-38-3958-3; ETN-93-92264) Copyright Avail: CASI HC A05/MF A01

A pluridisciplinary project uniting instrument designers, computer specialists and the users of telemapping systems, is described. Finnish business development considerations for an imaging spectrometer project are addressed. Telemapping microwave instruments are discussed. An aerial geological measuring system is described together with the twin jet aircraft it will be carried on. The recording of atmospheric measurements from an aeroplane is assessed. The use of imaging spectrometers in telemapping is discussed and the interpretation of the images is considered. For individual titles, see N93-19872 through N93-19880.

**N93-19872#** Technical Research Centre of Finland, Espoo. Instrument Lab.

**WHAT IS THE AERIAL TELEMAPPING SYSTEM? [MIKA ON LENTOKAUKOKARTOITUSJARJESTELMA?]**

Tuomas Hame *In its* Airborne Remote Sensing 1991 p 6-10 In FINNISH (For primary document see N93-19871 06-43)

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Thanks to data collected by aeroplanes, it is possible to obtain a working knowledge of the analysis of future satellite data. Recordings made by planes enable the completion of satellite observations. In the aerial telemapping system diverse photographic and measuring instruments simultaneously or quasi simultaneously map the surroundings. The processing and interpretation of the data are as important as their collection. A pluridisciplinary project uniting the instrument designers, computer specialists and the designers and users of telemapping systems is addressed. The program covers the years 1991 to 1994. ESA

**N93-19873#** Technical Research Centre of Finland, Espoo. Instrument Lab.

**BUSINESS DEVELOPMENT CONSIDERATIONS FOR THE IMAGING SPECTROMETER PROJECT**

John Bolton *In its* Airborne Remote Sensing 1991 p 11-18 (For primary document see N93-19871 06-43)

Copyright Avail: CASI HC A02/MF A01

The advantages for Finnish business that would result from the development of an imaging spectrometer are discussed. Development requirements and applications for the imaging spectrometer are considered. The imaging spectrometer is a powerful tool for the collection of remote sensing data. Its power lies in its ability to provide high spectral resolution as well as high spatial resolution. This power comes at some cost. The high spatial and spectral resolution means that the instrument will have a high data rate. To maintain the high resolution, the instrument must be built to high standards of electronic, mechanical and optical stability. The extensive conceptual design study for an imaging spectrometer is described. A plan that describes four phases of development, from an airborne imaging spectrometer to a fully space flight qualified instrument, is presented. ESA

**N93-19874#** Technical Research Centre of Finland, Espoo. Avaruustekniikan Lab.

**MICROWAVE INSTRUMENTS [MIKROAALTOALUEEN INSTRUMENTIT]**

Martti Hallikainen, Esa Panula-Ontto, Pekka Ahola, Juha Koivula, Lauri Kurvonen, Jorma Pallonen, Juha Hyyppa, Juhani Talvela, and Simo Tauriainen *In its* Airborne Remote Sensing 1991 p 19-28 In FINNISH (For primary document see N93-19871 06-43)

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Numerous microwave telemapping instruments usable in flight have been designed and built. Microwave radiometers and radars are used in campaigns to measure forests, snow and the sea. Up to the present these measurements were taken from helicopters. Instruments needing to be carried on an aeroplane are presently under construction. The adaptation of different types of planes to telemapping was studied. Microwave apparatus and different types of planes are described. The principal characteristics of the different instruments are given. ESA

**N93-19875#** Geological Inst., Helsinki (Finland).

**THE GEOLOGICAL RESEARCH CENTER'S AERIAL GEOLOGICAL MEASURING SYSTEM [GEOLOGIAN TUTKIMUSKESKUKSEN GEOFYSIKAALINEN LENTOMITTAUSJARJESTELMA]**

Ari Poikonen *In* Technical Research Centre of Finland, Airborne Remote Sensing 1991 p 29-35 In FINNISH (For primary document see N93-19871 06-43)

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The geological research center has been carrying out systematic aerial geophysical measurements of Finland since the 1950s, with the aim of mapping the magnetic and electrical characteristics and the natural gamma radiation of the ground and deep rock. This information has been exploited by Finnish geological studies, by mining companies and by other prospectors. The present low altitude flight program will continue into the next century. The plane used is a twin jet DHC-6 aircraft equipped with a 256(1024) channel gamma spectrometer two magnetometers and two electromagnetic audio frequency systems. ESA

**N93-19876#** Finnish Meteorological Inst., Helsinki.

**ATMOSPHERIC MEASUREMENTS TAKEN FROM AN AEROPLANE [ILMAKEHAMITTAUKSET LENTOKONEESTA]**

Sakari Uppala *In* Technical Research Centre of Finland, Airborne Remote Sensing 1991 p 36-38 In FINNISH (For primary document see N93-19871 06-43)
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In numerous countries atmospheric measurements have been made from aeroplanes for a long time. These measurements give information on the dynamic state of the atmosphere as well as the physical, chemical and radiative characteristics of clouds. The important experimenting of future satellite instruments and the sampling measurements of operational satellites are reviewed. The characteristics and possible operational activities of the aeroplane that Finland hopes to acquire are considered. ESA

**N93-19877#** Geodetic Inst., Helsinki (Finland).
**PRESENT AND FUTURE IMAGING SPECTROMETERS IN TELEMAPPING [NYKYISET JA TULEVAT KUVAAVAT SPEKTROMETRIT KAUKOKARTOITUKSESSA]**
Risto Kuittinen *In* Technical Research Centre of Finland, Airborne Remote Sensing 1991 p 40-47 In FINNISH (For primary document see N93-19871 06-43)
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The imaging spectrometer measures the radiation spectra reflected by the target for each element of ground for which the incident radiation gives an image. They play an important role in telemapping because they give information on the spectral characteristics of vast regions. Measurements made from planes with this equipment is positive and towards the end of the decade telemapping satellites will be equipped with some of these detectors. Imaging spectrometers must be developed, particularly with regard to the signal processing, in order to be able to satisfy the demands of operational measures. ESA

**N93-19878#** Technical Research Centre of Finland, Espoo. Instrument Lab.
**THE USE OF IMAGING SPECTROMETERS [KUVAAVIEN SPEKTROMETRIEN KAYTON SOVELLUTUKSET]**
Kai Maekisara *In its* Airborne Remote Sensing 1991 p 48-53 In FINNISH (For primary document see N93-19871 06-43)
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The principals according to which the applications of imaging spectrometers can be developed are considered and a few existing applications are presented. Means of exploiting a large number of channels, the necessity of a verification and the physical and chemical basis of applications are amongst the subjects addressed. ESA

**N93-19879#** Technical Research Centre of Finland, Espoo. Instrument Lab.
**EXPERIENCE OF THE FINNISH NATIONAL SCIENTIFIC RESEARCH CENTER (VTT) IN THE INTERPRETATION OF AVIRIS SPECTROMETRIC IMAGE [VTT:N KOKEMUKSIA AVIRIS-SPEKTROMETRIKUVIEN TULKINNASTA]**
Eija Parmes *In its* Airborne Remote Sensing 1991 p 54-60 In FINNISH (For primary document see N93-19871 06-43)
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Images of the Maine region (north east U.S.) taken from an aeroplane with AVIRIS (Airborne Visible and Infrared Imaging Spectrometer) were obtained. This data contains observations of 224 spectral bands about 10 nm wide, covering a spectral domain of 400 by 2450 nm. Unlike SPOT and LANDSAT satellite images, a supplementary variable is obtained from the data corresponding to the transition zone between the red and near infrared light, called the 'red transition' which is on the maximum of the spectral curve between 680 and 740 nm. The red transition is strongly correlated to the chlorophyll in the vegetation: an increase in the amount of chlorophyll brings about a displacement of the red transition towards a longer wavelength. ESA

**N93-19880#** Technical Research Centre of Finland, Espoo. Instrument Lab.
**AIRBORNE IMAGING SPECTROMETER DEVELOPMENT TASKS** **c35**
John Bolten *In its* Airborne Remote Sensing 1991 p 61-73 (For primary document see N93-19871 06-43)
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The tasks that must be completed to design and build an airborne imaging spectrometer are listed. The manpower and resources required to do these tasks must be estimated by the people responsible for that work. The tasks are broken down by instrument subsystem or discipline. The instrument performance can be assessed at various stages during the development. The initial assessment should be done with the preliminary computer model. The instrument calibration facilities should be designed, but no calibration facilities are needed. The intermediate assessment can be done when the front end has been assembled. The preliminary instrument calibration facility should be available at this stage. The final assessment can only be done when the instrument is complete and ready for flight. For this, the final instrument calibration facility and the flight qualification facilities must be ready. The final assessment is discussed in each discipline under the section on integration and test. ESA

**N93-19943*#** New York Univ., New York. Dept. of Applied Science.
**THE DYNAMICS OF HYDROPONIC CROPS FOR SIMULATION STUDIES OF THE CELSS INITIAL REFERENCE CONFIGURATIONS Status Report, 1 Jun. - 30 Nov. 1992**
Tyler Volk 30 Nov. 1992 13 p
(Contract NCC2-608)
(NASA-CR-192101; NAS 1.26:192101) Avail: CASI HC A03/MF A01

The goal of this research is to develop a progressive series of mathematical models for the CELSS hydroponic crops. These models will systematize the experimental findings from the crop researchers in the CELSS Program into a form useful to investigate system-level considerations, for example, dynamic studies of the CELSS Initial Reference Configurations. The crop models will organize data from different crops into a common modeling framework. This is the fifth semiannual report for this project. The following topics are discussed: (1) use of field crop models to explore phasic control of CELSS crops for optimizing yield; (2) seminar presented at Purdue CELSS NSCORT; and (3) paper submitted on analysis of bioprocessing of inedible plant materials. Author

**N93-18921*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**FAULT IDENTIFICATION USING MULTIDISCIPLINARY TECHNIQUES AT THE MARS/URANUS STATION ANTENNA SITES**
D. S. Santo, M. B. Schluter, and R. J. Shlemon *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 278-294
(For primary document see N93-18897 06-32)
(RTOP 314-40-42-20-10)
Avail: CASI HC A03/MF A03

## 44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

**N93-18527#** International Fuel Cells Corp., South Windsor, CT.
**SIMULATED COAL-GAS-FUELED MOLTEN CARBONATE FUEL CELL DEVELOPMENT PROGRAM**
Aug. 1992 203 p
(Contract DE-AC21-91MC-27393)
(DE93-000205; DOE/MC-27393/3125; FCR-12328) Avail: CASI HC A10/MF A03

This work consists of five major tasks and their respective subtasks as listed below. A brief description of each task is also provided. The Stack Design Requirements task focused on requirements and specification for designing, constructing, and testing a nominal 100-kilowatt integrated stack and on requirements for the balance-of-plant equipment to support a 1000-kilowatt integrated stack demonstrator. The Stack Design Preparation task focused on the mechanical design of a 100-kilowatt stack comprised of 8-ft(exp 2) cells incorporating the new cell configuration and component technology improvements developed in the previous DOE MCFC contract. Electrode Casting focused on developing a faster drying solvent for use in the electrode tape casting process. Electrode Heat Treatment was directed at scaling up the laboratory continuous debinding process to a new full-size IFC debinding oven coupled to a continuous belt furnace that will both debind and sinter the electrodes in one continuous process train. Repeat

Part Quality Assurance and Testing provided the appropriate effort to ensure consistent, high-quality, reproducible and comparable repeat parts. DOE

**N93-18601*#** Auburn Univ., AL. Space Power Inst.
**HYPERVELOCITY IMPACT EFFECTS ON SOLAR CELLS Final Technical Report**
M. Frank Rose 21 Jan. 1993 6 p
(Contract NAS8-39131)
(NASA-CR-192444; NAS 1.26:192444) Avail: CASI HC A02/MF A01

One of the space hazards of concern is the problem of natural matter and space debris impacting spacecraft. This phenomena has been studied since the early sixties and a methodology has been established to determine the relative abundance of meteoroids as a function of mass. As the mass decreases, the probability of suffering collisions increases, resulting in a constant bombardment from particles in the sub-micron range. The composition of this 'cosmic dust' is primarily Fe, Ni, Al, Mg, Na, Ca, Cr, H, O, and Mn. In addition to mechanical damage, impact velocities greater than 5 k m/sec can produce shock induced ionization effects with resultant surface charging and complex chemical interactions. The upper limit of the velocity distribution for these particles is on the order of 70 km/sec. The purpose of this work was to subject samples from solar power arrays to debris flux typical of what would be encountered in space, and measure the degradation of the panels after impact. Author

**N93-18656#** Midwest Research Inst., Golden, CO. National Renewable Energy Lab.
**RESEARCH ON POLYCRYSTALLINE THIN-FILM CuGaInSe2 SOLAR CELLS**
B. J. Stanbery, W. S. Chen, W. E. Devaney, and J. W. Stewart Nov. 1992 17 p Prepared in cooperation with Boeing Co., Seattle, WA
(Contract DE-AC02-83CH-10093)
(DE92-016439; NREL/TP-413-5012) Avail: CASI HC A03/MF A01

This report describes research to fabricate high-efficiency CdZnS/CuInGaSe2 (CIGS) thin-film solar cells, and to develop improved transparent conductor window layers such as ZnO. A specific technical milestone was the demonstration of an air mass (AM) 1.5 global, 13 percent efficient, 1-sq cm total-area CIGS thin-film solar cell. Our activities focused on three areas. First, a CIGS deposition system was modified to double its substrate capacity, thus increasing throughput, which is critical to speeding the process development by providing multiple substrates from the same CIGS run. Second, new tooling was developed to enable an investigation of a modified aqueous CdZnS process. The goal was to improve the yield of this critical step in the device fabrication process. Third, our ZnO sputtering system was upgraded to improve its reliability, and the sputtering parameters were further optimized to improve its properties as a transparent conducting oxide. The characterization of the new CIGS deposition system substrate fixturing was completed, and we produced good thermal uniformity and adequately high temperatures for device-quality CIGS deposition. Both the CIGS and ZnO deposition processes were refined to yield a ZnO / Cd(0.82)Zn(0.18)S / CuIn(0.80)Ga(0.20)Se2 cell that was verified at NREL under standard testing conditions at 13.1 percent efficiency with V(sub oc) = 0.581 V, J(sub sc) = 34.8 mA/sq cm, FF = 0.728, and a cell area of 0.979 sq cm. DOE

**N93-18657#** Midwest Research Inst., Golden, CO. National Renewable Energy Lab.
**RESEARCH ON STABLE, HIGH-EFFICIENCY AMORPHOUS SILICON MULTIJUNCTION MODULES**
S. Guha Sep. 1992 32 p Prepared in cooperation with United Solar Systems Corp., Troy, MI
(Contract DE-AC02-83CH-10093)
(DE93-000011; NREL/TP-411-5063) Avail: CASI HC A03/MF A01

This report describes research on semiconductor and non-semiconductor materials to enhance the performance of multi-band-gap, multijunction, amorphous silicon-based alloy modules with an area greater than 900 sq cm by 1992. Double-junction and triple-junction cells are made on a Ag/ZnO back reflector deposited on stainless steel substrates. An a-SiGe alloy is used for the i-layer in the bottom and the middle cells; the top cell uses an amorphous silicon alloy. After the evaporation of an antireflection coating, silver grids and bus bars are put on the top surface and the panel is encapsulated in an ethylene vinyl acetate (EVA)/Tefzel structure to make a 1-sq ft monolithic module. DOE

**N93-18705#** Midwest Research Inst., Golden, CO. National Renewable Energy Lab.
**A DISCUSSION OF THE RESULTS OF THE RAINFLOW COUNTING OF A WIDE RANGE OF DYNAMICS ASSOCIATED WITH THE SIMULTANEOUS OPERATION OF ADJACENT WIND TURBINES**
N. Kelley, G. Desrochers, J. Tangler, and B. Smith Oct. 1992 9 p Presented at the Windpower 1992, Seattle, WA, 19-23 Oct. 1992
(Contract DE-AC02-83CH-10093)
(DE93-000016; NREL/TP-442-5159; CONF-921049-2) Avail: CASI HC A02/MF A01

The objective of this study was to provide a fatigue load comparison between two identical wind turbines employing different rotor designs. One turbine was fitted with a rotor consisting of a set of NREL (SERI) thin-airfoil blades while the other rotor included the original-equipment AeroStar blades. The data discussed are based on sample load populations derived from the rainflow cycle counting of 405, 10-minute records specifically collected over a wide range of inflow turbulence conditions. The results have shown that the statistical structure of the alternating load cycles on both turbines can be described as a mixture of three stochastic processes. We noted a high degree of load distribution similarity between the two turbines, with the differences attributable to either rotor weight or swept area. DOE

**N93-18866*#** Electro-Optek Corp., Torrance, CA.
**FABRICATION OF PHOTOVOLTAIC LASER ENERGY CONVERTERBY MBE**
Hamilton Lu, Scott Wang, and W. S. Chan Washington Jan. 1993 62 p
(Contract NAS1-19090; RTOP 324-02-01)
(NASA-CR-4484; NAS 1.26:4484) Avail: CASI HC A04/MF A01

A laser-energy converter, fabricated by molecular beam epitaxy (MBE), was developed. This converter is a stack of vertical p-n junctions connected in series by low-resistivity, lattice matched CoSi2 layers to achieve a high conversion efficiency. Special high-temperature electron-beam (e-beam) sources were developed especially for the MBE growth of the junctions and CoSi2 layers. Making use of the small (greater than 1.2 percent) lattice mismatch between CoSi2 and Si layers, high-quality and pinhole-free epilayers were achieved, providing a capability of fabricating all the junctions and connecting layers as a single growth process with one pumpdown. Well-defined multiple p-n junctions connected by CoSi2 layers were accomplished by employing a low growth temperature (greater than 700 C) and a low growth rate (less than 0.5 microns/hour). Producing negligible interdiffusion, the low growth temperature and rate also produced negligible pinholes in the CoSi2 layers. For the first time, a stack of three p-n junctions connected by two 10(exp -5) Ohm-cm CoSi2 layers was achieved, meeting the high conversion efficiency requirement. This process can now be optimized for high growth rate to form a practical converter with 10 p-n junctions in the stack. Author

**N93-19474#** Sandia National Labs., Albuquerque, NM.
**THE STATUS OF PHOTOVOLTAIC CONCENTRATOR DEVELOPMENT**
A. B. Maish 1992 13 p Presented at the 11th European Photovoltaic Solar Energy Conference and Exhibition, Montreux, Switzerland, 12-16 Oct. 1992
(Contract DE-AC04-76DP-00789)
(DE93-002298; SAND-92-0604C; CONF-921010-1) Avail: CASI HC A03/MF A01

Several companies in the United States are actively pursuing the commercialization of photovoltaic concentrator technology. Under the auspices of the US Department of Energy's Concentrator Initiative, the Electric Power Research Institute's High Concentration Photovoltaic Program, and several privately funded programs, these companies are developing a range of designs from low-concentration linear-focus to high-concentration point-focus cells and collectors. Design details and status of each development program is presented. DOE

**N93-19613#** Horizon Data Corp., Reston, VA. Power Information Center.
**INTERAGENCY ADVANCED POWER GROUP SEMI-ANNUAL COMPILATION OF BRIEFS, SEPTEMBER 1992**
1 Oct. 1992 327 p
(Contract DE-AC01-90CE-90053)
(DE93-000703; DOE/CE-90053/T26) Avail: CASI HC A15/MF A03

Project briefs are presented for the chemical, electrical, MHD, mechanical, nuclear, solar, and systems working groups. DOE

**N93-19622#** Energy Research Corp., Danbury, CT.
**INTEGRATION OF CARBONATE FUEL CELLS WITH ADVANCED COAL GASIFICATION SYSTEMS**
G. Steinfeld, S. J. Meyers (Fluor Daniel, Inc., Irvine, CA.), and W. B. Hauserman (North Dakota Univ., Grand Forks.) 1992 6 p Presented at the Fuel Cell Seminar, Tucson, AZ, 29 Nov. - 2 Dec. 1992
(Contract DE-AC21-90MC-27227)
(DE93-003485; DOE/MC-27227/93/C0136; CONF-921114-3) Avail: CASI HC A02/MF A01

Carbonate fuel cells have attributes which make them ideally suited to operate on coal-derived fuel gas; they can convert the methane, hydrogen, and carbon monoxide present in coal derived fuel gas directly to electricity, are not subject to thermodynamic cycle limits as are heat engines, and operate at temperatures compatible with coal gasifiers. Some new opportunities for improved efficiency have been identified in integrated coal gasification/carbonate fuel cells which take advantage of low temperature catalytic coal gasification producing a methane-rich fuel gas, and the internal methane reforming capabilities of Energy Research Corporation's carbonate fuel cells. By selecting the appropriate operating conditions and catalyst in the gasifier, methane formation is maximized to improve gasification efficiency and to take advantage of the heat management aspects of the internal reforming carbonate fuel cell. These advanced integrated gasification/carbonate fuel cell systems are projected to have better efficiencies than gasification/carbonate fuel cell systems employing conventional gasification, and also competing non-fuel cell systems. These improved efficiencies would be accompanied by a corresponding reduction in impact on the environment as well. DOE

**N93-19623#** Sandia National Labs., Albuquerque, NM.
**SPIN DEPENDENT PHOTOCURRENTS IN RIBBON SOLAR CELLS**
C. H. Seager, E. L. Venturini, and W. K. Schubert 1992 10 p Presented at the 2nd Workshop on Role of Point Defects/Defect Complexes in Silicon Device Fabrication, Breckenridge, CO, 24-26 Aug. 1992
(Contract DE-AC04-76DP-00789)
(DE93-002486; SAND-92-1825C; CONF-9208175-1) Avail: CASI HC A02/MF A01

Spin Dependent Transport (SDT) is a method of identifying recombination centers which employs a microwave resonance condition to affect the recombination rate of minority carriers in a device. When this technique is used to analyze the diffusion-limited currents produced by long-wavelength optical excitation, it has the potential to chemically identify the major recombination sites in solar cells. We have used this resonance technique to analyze short circuit photocurrents in Edge-defined film-Fed Growth (EFG) ribbon silicon solar cells. At room temperature, our observed photocurrent resonances have zero-crossing g values and linewidths which are similar to SDT observations made on the trans-barrier currents in silicon bicrystals, and electron spin resonance signals seen in damaged silicon, and polycrystalline silicon. These dangling-bond-like SDT signals depend on cell illumination levels in a way that suggests that the values of recombination velocity at electrically active linear boundaries decrease with illumination intensity. Hydrogen processed cells show markedly smaller SDT response, consistent with the passivation of Si dangling bond defects. While most of our SDT observations have been made on n(sup +)/p EFG cells, we suggest that measurements made at low temperatures on other cell structures might uncover resonances due to other recombination centers in this material. DOE

**N93-18476#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**INDIUM PHOSPHIDE PHOTOVOLTAIC TECHNOLOGY**
L. F. Halle and D. C. Marvin *In its* Aerospace Sponsored Research 1 Dec. 1991 p 56-59 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

## 45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

**N93-17912#** Franklin Inst., Philadelphia, PA. Science Museum.
**GREENHOUSE EARTH: A TRAVELING EXHIBITION**
W. H. Booth and S. Caesar Sep. 1992 8 p
(Contract DE-FG02-91ER-75637)
(DE93-002419; DOE/ER-75637/1) Avail: CASI HC A02/MF A01

The Franklin Institute Science Museum provided an exhibit entitled the Greenhouse Earth: A Traveling Exhibition. This 3500 square-foot exhibit on global climate change was developed in collaboration with the Association of Science-Technology Centers. The exhibit opened at The Franklin Institute on February 14, 1992, welcoming 291,000 visitors over its three-month stay. During its three-year tour, Greenhouse Earth will travel to ten US cities, reaching two million visitors. Greenhouse Earth aims to deepen public understanding of the scientific issues of global warming and the conservation measures that can be taken to slow its effects. The exhibit features hands-on exhibitry, interactive computer programs and videos, a theater production, a 'demonstration cart', guided tours, and lectures. Supplemental educational programs at the Institute included a teachers preview, a symposium on climate change, and a 'satellite field trip'. The development of Greenhouse Earth included front-end and formative evaluation procedures. Evaluation includes interviews with visitors, prototypes, and summative surveys for participating museums. During its stay in Philadelphia, Greenhouse Earth was covered by the local and national press, with reviews in print and broadcast media. Greenhouse Earth is the first large-scale museum exhibit to address global climate change. DOE

**N93-18095#** World Meteorological Organization, Geneva (Switzerland).
**HYDROLOGICAL ASPECTS OF ACCIDENTAL POLLUTION OF WATER BODIES**
1992 213 p
(WMO-754; OH-37; ISBN-92-63-10754-8; ETN-93-93024) Copyright
Avail: CASI MF A03; print copy available at WMO, Geneva, Switzerland

Guidance material on methods, techniques, and procedures for use in monitoring and forecasting of contaminant transport and migration in water bodies following accidental release of pollutants is provided. Topics covered include: types and sources of accidental pollution; processes of contaminant transport; migration of contaminants in water bodies; data collection to monitor the contamination and transport; methods of calculating and forecasting pollutant transport in water bodies; reporting of accidental pollution; and administrative and technical aspects of transboundary pollution. Nine case studies, including a description of the radioactive contamination of water bodies following the Chernobyl nuclear accident, are presented. ESA

**N93-18319#** National Science Foundation, Washington, DC.
**GLOBAL CHANGE RESEARCH PROGRAM: A COMPONENT OF THE US GLOBAL CHANGE RESEARCH PROGRAM. 1993 RESEARCH OPPORTUNITIES**
1992 36 p Supersedes NSF-91-33 Original contains color illustrations
(NSF-92-77; NSF-91-33) Avail: CASI HC A03/MF A01

The necessity for understanding our global environment, its natural variability, and the changes imposed on it through human activities is recognized internationally. In the United States, the high priority placed by the Government on understanding the global environment led to the establishment of the U.S. Global Change Research Program. The program is an integrated research effort with the goal of establishing the scientific basis for national and international policymaking related to natural and human-induced changes in the global Earth system and their regional impacts. Within this program, the National Science Foundation, one of the funding agencies, is responsible for maintaining the health of basic research in all areas of solid Earth, atmospheric, ocean, terrestrial, and social sciences as well as research in polar regions. The basic research program is focused on ground-based studies on regional and global scales; large-scale field programs; interpretation and use of remotely sensed data and geographic information systems; theoretical and laboratory research; research facilities support; and the development of numerical models, information and communication systems, and data bases. Research opportunities with NSF are described. L.R.R.

**N93-18393#** Atmospheric and Environmental Research, Inc., Cambridge, MA.

**NATURAL AND ANTHROPOGENIC CLIMATE CHANGE**

M. K. W. Ko, S. A. Clough, G. I. Molnar, M. Iacono, and W. C. Wang Mar. 1992 10 p

(Contract DE-FG02-86ER-60485)

(DE93-003150; DOE/ER-60485/4) Avail: CASI HC A02/MF A01

This report consists of two parts: (1) progress for the period 1 Sep. 91 - 31 Mar. 92; and (2) the plan for the remaining period 1 Apr. 92 - 31 Aug. 92. The project includes two tasks: atmospheric radiation; and improvement of climate models to evaluate the climatic effects of radiation changes. The atmospheric radiation task includes four subtasks: (1) Intercomparison of Radiation Codes in Climate Models (ICRCCM); (2) analysis of the water vapor continuum using line-by-line calculations to develop a parameterization for use in climate models; (3) parameterization of longwave radiation; and (4) climate/radiation interactions of desert aerosols. Our effort in this period is focused on the first three subtasks. The improvement of climate models to evaluate the subtasks: (1) general circulation model study; and (2) 2-D model development and application. DOE

**N93-18405#** Department of Energy, Washington, DC. Office of Health and Environmental Research.

**GLOBAL CHANGE RESEARCH: SUMMARIES OF RESEARCH IN FY 1992**

Oct. 1992 196 p

(DE93-002859; DOE/ER-0565T) Avail: CASI HC A09/MF A03

Greenhouse gases result from both natural and man-made processes and include carbon dioxide (CO2), nitrogen oxides (N(x)O(y)), methane, chlorofluorocarbons, halogenated compounds, water vapor, and others. Since the industrial revolution, the atmospheric concentrations of several greenhouse gases have been increasing, primarily because of human activities. These increases have the potential to cause global climate change through increased radiative forcing. Global climate change is a significant issue for the Department of Energy (DOE) because energy production and use now contribute more than half of the total man-made emissions of greenhouse gases on a global basis. The missions of the Department's Global Change Research Program are: to predict the future atmospheric concentrations of CO2 and other energy-related greenhouse gases; to predict the future and magnitude of potential climate change caused by the enhanced greenhouse effect; to understand both the direct impacts of greenhouse-gas emissions on biota and the indirect consequences produced by climate change; to assess the impacts of global climate change on energy systems and energy demand; and to develop and assess the potential of mitigation and adaptation technologies and practices to offset or limit the impact of any potential climate change or to facilitate natural and societal adjustment to the environmental, social, and economic consequences of global climate changes. The information produced by these activities is necessary in order to assess the economic and environmental costs and benefits of both potential climate change caused by the effects of greenhouse gases and implementing different technologies and energy-policy options aimed at preventing, mitigating, or adapting to such change. This document describes the activities and products of the Global Change Research Program in FY 1992. DOE

**N93-18438*#** University Corp. for Atmospheric Research, Boulder, CO. Office for Interdisciplinary Earth Studies.

**REPORTS TO THE NATION ON OUR CHANGING PLANET. FALL 1992, NO. 2: OUR OZONE SHIELD Semiannual Report, Apr. - Sep. 1992**

1992 22 p LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by color photographs Original contains color illustrations

(Contract NCC5-42)

(NASA-CR-190953; NAS 1.26:190953) Avail: CASI HC A03/MF A01; 19 functional color pages

This document is the second in a series of publications on climate and global change intended for public education. They are a joint effort of the UCAR Office for Interdisciplinary Earth Studies and the NOAA Office of Global Programs. The various roles of atmospheric ozone are described and the mechanisms and consequences of stratospheric ozone depletion are discussed. Author

**N93-18587#** Argonne National Lab., IL.

**AQUIS: A PC-BASED AIR QUALITY AND PERMIT INFORMATION SYSTEM**

A. E. Smith, C. C. Huber, J. Tschanz, and J. S. Ryckman, Jr. 1992 13 p Presented at the International Symposium on Energy, Environment and Information Management, Argonne, IL, 15-18 Sep. 1992

(Contract W-31-109-eng-38)

(DE92-040092; ANL/CP-76983; CONF-9209160-20) Avail: CASI HC A03/MF A01

The Air Quality Utility Information System (AQUIS) was developed to calculate and track emissions, permits, and related information. The system runs on IBM-compatible personal computers using dBASE 4. AQUIS tracks more than 900 data items distributed among various source categories and allows the user to enter specific information on permit control devices, stacks, and related regulatory requirements. The system is currently operating at seven US Air Force Materiel Command facilities, large industrial operations involved in the repair, and maintenance of aircraft. Environmental management personnel are responsible for the compliance status of as many as 1,000 sources at each facility. The usefulness of the system has been enhanced by providing a flexible reporting capability that permits users who are unfamiliar with database structure to design and prepare reports containing specified information. In addition to the standard six pollutants, AQUIS calculates compound-specific emissions and allows users to enter their own emission estimates. This capability will be useful in developing air toxics inventories and control plans. DOE

**N93-18600*#** Maryland Univ., College Park. Dept. of Meteorology.

**CLIMATE MODEL CALCULATIONS OF THE EFFECTS OF VOLCANOES ON GLOBAL CLIMATE Status Report, 1 Dec. 1991 - 30 Nov. 1992**

Alan Robock 1992 13 p

(Grant NAG5-1835)

(NASA-CR-191999; NAS 1.26:191999) Avail: CASI HC A03/MF A01

An examination of the Northern Hemisphere winter surface temperature patterns after the 12 largest volcanic eruptions from 1883-1992 shows warming over Eurasia and North America and cooling over the Middle East which are significant at the 95 percent level. This pattern is found in the first winter after tropical eruptions, in the first or second winter after midlatitude eruptions, and in the second winter after high latitude eruptions. The effects are independent of the hemisphere of the volcanoes. An enhanced zonal wind driven by heating of the tropical stratosphere by the volcanic aerosols is responsible for the regions of warming, while the cooling is caused by blocking of incoming sunlight. Author

**N93-18863*#** Miami Univ., FL. School of Marine and Atmospheric Sciences.

**LOW LEVEL MEASUREMENTS OF ATMOSPHERIC DMS, H2S, AND SO2 FOR GTE/CITE-3 Final Report, 1 Nov. 1988 - 31 Oct. 1991**

Eric Saltzman and David Cooper 31 Oct. 1991 40 p

(Grants NAG1-918; NSF ATM-87-09802)

(NASA-CR-191635; NAS 1.26:191635) Avail: CASI HC A03/MF A01

This project involved the measurement of atmospheric dimethylsulfide (DMS) and hydrogen sulfide (H2S) as part of the GTE/CITE-3 instrument intercomparison program. The two instruments were adapted for use on the NASA Electra aircraft and participated in all phases of the mission. This included ground-based measurements of NIST-provided standard gases and a series of airborne missions over the Western Atlantic Ocean. Analytical techniques used are described and the results are summarized. Author

**N93-18864** National Academy of Sciences - National Research Council, Washington, DC. Commission on Geosciences, Environment, and Resources.

**THE US GLOBAL CHANGE RESEARCH PROGRAM: EARLY ACHIEVEMENTS AND FUTURE DIRECTIONS**

John S. Perry 1992 23 p Sponsored in part by NSF, NASA, NOAA, US Geological Survey, US Dept. of Agriculture, Office of Naval Research, and DOE

(Grant NSF OCE-92-11921)

Copyright Avail: Issuing Activity

Almost a decade ago, a NASA-sponsored workshop called for a research initiative in the earth and life sciences directed at an intensely pragmatic question: How can we ensure the continuing habitability of our globe in the face of continued expansion in human numbers and activity? This

question led to the development of massive national and international research programs that built on a long tradition of large-scale field programs in the earth sciences. Views on what has been accomplished over the last decade are presented. These views are drawn primarily from the author's experience. The following issues in which global change has made a discernible difference are discussed: ozone depletion; the biosphere and the climate system; aerosols and climate; el nino-southern oscillation; the global carbon cycle; understanding past environments; economic and other human dimensions; the biosphere; integrated modeling of the earth system; and linkage between science and policy. Author

**N93-18870*#** District of Columbia Univ., Washington, DC.
**EFFECTS OF CLOUDS ON THE EARTH RADIATION BUDGET; SEASONAL AND INTER-ANNUAL PATTERNS Annual Report**
Harbans L. Dhuria 24 Dec. 1992 44 p
(Grant NAG5-1012)
(NASA-CR-191619; NAS 1.26:191619) Avail: CASI HC A03/MF A01

Seasonal and regional variations of clouds and their effects on the climatological parameters were studied. The climatological parameters surface temperature, solar insulation, short-wave absorbed, long wave emitted, and net radiation were considered. The data of climatological parameters consisted of about 20 parameters of Earth radiation budget and clouds of 2070 target areas which covered the globe. It consisted of daily and monthly averages of each parameter for each target area for the period, Jun. 1979 - May 1980. Cloud forcing and black body temperature at the top of the atmosphere were calculated. Interactions of clouds, cloud forcing, black body temperature, and the climatological parameters were investigated and analyzed. Author

**N93-18945#** Florida Univ., Fort Lauderdale. Research and Education Center.
**AQUATIC PLANT CONTROL RESEARCH PROGRAM. BIOLOGICAL CONTROL OF PISTIA STRATIOTES L. (WATERLETTUCE) USING NEOHYDRONOMUS AFFINIS HUSTACHE (COLEOPTERA: CURCULIONIDAE) Final Report**
F. Allen Dray, Jr. and Ted D. Center (Agricultural Research Service, Fort Lauderdale, FL.) Jul. 1992 65 p Sponsored by Army Engineer District
(AD-A257463; WES/TR/A-92-1) Avail: CASI HC A04/MF A01

Waterlettuce (Pistia stratiotes L.) is a floating plant that often interferes with the proper use of water resources. Consequently, releases of a biological control agent, Neohydronomus affinis Hustache (a weevil), were begun in April 1987 at several sites in southern Florida. Self-perpetuating populations had been established at four of these sites by September 1988. The plant and weevil populations were monitored on a monthly basis at three sites: Kreamer Island, Torry Island, and Port St. Lucie. By May 1989, Kreamer Island harbored about 45 million weevils, and the plant population had been reduced from 50 acres (202,343 sq m) to less than 5 acres (20,234 sq m). By May 1990, Torry Island harbored nearly 42 million weevils and P. stratiotes, which had previously filled the 10-acre (40,468 sq m) site, was virtually absent. The biocontrol agent population at Port St. Lucie never exceeded 100,000 weevils and had little apparent impact on the waterlettuce population at this site. Plants under stress from weevil herbivory at Kreamer Island and Torry Island were typically smaller, had fewer leaves, and grew less rapidly than healthy plants. As a result, waterlettuce populations harboring large weevil infestations exhibited reduced vigor, and standing crop and coverage declined until waterlettuce was virtually eliminated from these waterbodies. Why the Port St. Lucie populations failed to increase to damaging levels has not been determined, though several hypotheses present themselves. Weed control agencies in southern Florida have cooperated to spread this weevil from Torry and Kreamer Islands to other waterways. Additional sites have become infested as the weevils disperse on their own. GRA

**N93-19469#** Argonne National Lab., IL.
**A HYPERSPECTRAL IMAGE ANALYSIS WORKBENCH FOR ENVIRONMENTAL SCIENCE APPLICATIONS**
J. H. Christiansen, D. G. Zawada, K. L. Simunich, and J. C. Slater 1992 5 p Presented at the 9th International Conference on Interactive Information and Processing, Anaheim, CA, 17-22 Jan. 1993
(Contract W-31-109-eng-38)
(DE93-000603; ANL/CP-77460; CONF-930141-1) Avail: CASI HC A01/MF A01

A significant challenge to the information sciences is to provide more powerful and accessible means to exploit the enormous wealth of data available from high-resolution imaging spectrometry, or 'hyperspectral' imagery, for analysis, for mapping purposes, and for input to environmental modeling applications. As an initial response to this challenge, Argonne's Advanced Computer Applications Center has developed a workstation-based prototype software workbench which employs AI techniques and other advanced approaches to deduce surface characteristics and extract features from the hyperspectral images. Among its current capabilities, the prototype system can classify pixels by abstract surface type. The classification process employs neural network analysis of inputs which include pixel spectra and a variety of processed image metrics, including image 'texture spectra' derived from fractal signatures computed for subimage tiles at each wavelength. DOE

**N93-19484*#** Colorado Univ., Boulder. Cooperative Inst. for Research in Environmental Sciences.
**DETECTING CHANGE AS IT OCCURS**
Uwe Radok and Timothy J. Brown [1992] 15 p Sponsored in part by NOAA
(Grant NAGw-2706)
(NASA-CR-191939; NAS 1.26:191939) Avail: CASI HC A03/MF A01

Traditionally climate changes have been detected from long series of observations and long after they have happened. Our 'inverse sequential' procedure, for detecting change as soon as it occurs, describes the existing or most recent data by their frequency distribution. Its parameter(s) are estimated both from the existing set of observations and from the same set augmented by 1,2,...,j new observations. Individual-value probability products ('likelihoods') are used to form ratios which yield two probabilities for erroneously accepting the existing parameter(s) as valid for the augmented data set, and vice versa. A genuine parameter change is signaled when these probabilities (or a more stable compound probability) show a progressive decrease. New parameter values can then be estimated from the new observations alone using standard statistical techniques. The inverse sequential procedure will be illustrated for global annual mean temperatures (assumed normally distributed), and for annual numbers of North Atlantic hurricanes (assumed to represent Poisson distributions). The procedure was developed, but not yet tested, for linear or exponential trends, and for chi-squared means or degrees of freedom, a special measure of autocorrelation. Author

**N93-19505#** Colorado Univ., Boulder. Cooperative Inst. for Research in Environmental Sciences.
**THERMOHALINE CIRCULATIONS AND GLOBAL CLIMATE CHANGE Report, 15 Jan. - 14 Dec. 1992**
H. P. Hanson 1992 6 p
(Contract DE-FG02-90ER-61019)
(DE93-004601; DOE/ER-61019/3) Avail: CASI HC A02/MF A01

This report discusses research activities conducted during the period 15 January 1992 to 14 December 1992. Thermohaline Circulations and Global Climate Change is concerned with investigating the hypothesis that changes in surface thermal and hydrological forcing of the North Atlantic, changes that might be expected to accompany CO2-induced global warming, could result in ocean-atmosphere interactions' exerting a positive feedback on the climate system. Because the North Atlantic is the source of much of the global ocean's reservoir of deep water, and because this deep water could sequester large amounts of anthropogenically produced CO2, changes in the rate of deep-water production are important to future climates. Since deep-water Production is controlled, in part, by the annual cycle of the atmospheric forcing of the North Atlantic, and since this forcing depends strongly on both hydrological and thermal processes as well as the windstress, there is the potential for feedback between the relatively short-term response of the atmosphere to changing radiative forcing and the longer-term processes in the oceans. Work over the past 11 months has proceeded according to the continuation discussion of last January and several new results have arisen. DOE

**N93-19628#** Oak Ridge National Lab., TN.
**METADATA IN ARCHIVES: THE ATMOSPHERIC RADIATION MEASUREMENT (ARM) ARCHIVE EXPERIENCE**
P. F. Daugherty and P. T. Singley Oct. 1992 7 p Presented at the Scientific Data Management Workshop 1992, Salt Lake City, UT, 3-5 Nov.

1992
(Contract DE-AC05-84OR-21400)
(DE93-003011; CONF-9211115-2) Avail: CASI HC A02/MF A01

Modern scientific research archives are charged with storing data and metadata from many sources, with organizing both the data and metadata to allow users to make a broad range of queries, and with describing the archived data well enough to make it useful. This discussion of our experiences with the ARM Archive illustrates some of the uses of metadata, and some of the issues surrounding developing and managing metadata in an archival setting. DOE

**N93-19831#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**COMPARATIVE ANALYSIS OF THE INDICES OF VEGETATION IN URBAN AREAS OBTAINED FROM THE TM-LANDSAT AND HRV-SPOT DATA: CITY OF TAUBATE [ANALISE COMPARATIVA DOS INDICES DE VEGETACAO EM AREAS URBANAS OBTIDOS DE DADOS TM-LANDSAT E HRV-SPOT: CIDADE DE TAUBATE]**
Ana Lucia Ramos Carrara Jan. 1992 187 p In PORTUGESE
(INPE-5418-TDI/482) Avail: CASI HC A09/MF A02

The intense and disorganized urbanization in most of brazilian cities has been causing a process of degradation of natural urban environment where the presence of the vegetation element is getting scarce. The qualitatively and quantitatively balance of 'green urban spaces' is a basic information to do adequate planning in order to improve the quality of urban environment. A special transformation realized with orbital data, namely the 'Vegetation Index' (VI) allows the qualitative and quantitative study or urban vegetation. The purpose of this work is to realize a comparative analysis of the Normalized Difference Vegetation Index (NDVI) in urban areas obtained from TM-Landsat and HRV-SPOT data. This study was developed in the urban area of the municipality of Taubate located in the Paraiba Valley, Sao Paulo state. The calculation of the VI was done from orbital data from sensors TM-Landsat and HRV-SPOT in the red, near-infrared and middle-infrared regions of the electromagnetic spectrum. The aerial photography helped to obtain ground information and to measure the vegetal cover percentage, founded in the different urban iand use. In the results it was found that: the NDVI calculated by TM-Landsat and HRV-SPOT data, with its different spatial and spectral characteristics allowed to obtain distinct classification associated urban use and vegetal cover; a good relationship was found between the NDVI from both orbital data and the vegetal cover percentage. It was possible to conclude that the VI turned out to be a good estimator of green areas in comparison with the built up areas permitting a global view of vegetal cover spatial distribution and density. In a qualitative analysis the NDVI has shown to be a good indicator of the residential sector quality of life. Author

**N93-19940*#** National Aeronautics and Space Administration, Washington, DC.
**GLOBAL CHANGE INFORMATION SUPPORT: A NORTH-SOUTH COALITION**
Walter R. Blados and Gladys A. Cotter Jan. 1993 13 p
(NASA-TM-108983; NAS 1.15:108983) Avail: CASI HC A03/MF A01

On a daily basis we become more aware that our planet, earth, exists in a delicate balance; we, its inhabitants, must be informed caretakers. Global change communities have emerged around the globe to address this multidisciplinary subject. Information systems that integrate text, bibliographic, numeric and visual data are needed to support these global change communities. No one information center can hope to collect all the relevant data. Rather, we must form a coalition, North and South, to collect and provide access to disparate, multidisciplinary sources of information, and to develop standardized tools for documenting and manipulating this data and information. International resources need to be mobilized in a coordinated manner to move us towards this goal. This paper looks at emerging information technologies that can be utilized to build such a system, and outlines some cooperative North/South strategies. Author

**N93-18500#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**TRENDS IN MIDDLE-ATMOSPHERE OZONE**
M. N. Ross *In its* Aerospace Sponsored Research 1 Dec. 1991 p 133-134 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18963*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**GEODYNAMIC CONTRIBUTIONS TO GLOBAL CLIMATIC CHANGE**
Bruce G. Bills *In its* Orbital, Rotational and Climatic Interactions Dec. 1992 p 1-33 (For primary document see N93-18962 06-46)
Avail: CASI HC A03/MF A02

**N93-19396*#** Purdue Univ., Indianapolis, IN. Agricultural Engineering Dept.
**WATER QUALITY MODELING USING GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA**
Bernard A Engel *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 143-170 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

# 46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

**N93-17907#** Massachusetts Univ., Lowell. Center for Atmospheric Research.
**MEASUREMENTS OF F-REGION DRIFT VELOCITIES AT THE DUSK SECTOR MID-LATITUDE TROUGH Report No. 1**
James L. Scali and Bodo W. Reinisch Mar. 1992 38 p
(Contract F19628-90-K-0005)
(AD-A257766; DD-E201264; PL-TR-92-2094) Avail: CASI HC A03/MF A01

Drift velocities measured at the high latitude Digisonde stations in Goose Bay, Argentia, and Millstone Hill are used to investigate the formation of mid-latitude troughs in the dusk sector. The observations show the existence of westward drift velocities of magnitudes comparable to the velocity of the earth's rotation during trough formation. These drifts are part of the two cell convection pattern as implied by the stagnation theory of trough formation. GRA

**N93-17957#** Rome Univ. (Italy). Dipt. di Fisica.
**SPECTRAL FEATURES (200 nm - 10 MICROMETERS) OF ATMOSPHERIC MOLECULES: A BIBLIOGRAPHY (1979-1990)**
Giovanni Turco, Antonella Amoruso, and Giorgio Fiocco 3 Jun. 1991 190 p Sponsored by Programma Nazionale Ricerche, Antartide, Italy
(Nota-Interna-982; ETN-93-93346) Avail: CASI HC A09/MF A02

A survey of publications appearing from 1979 to 1990 concerning spectral features of atmospheric molecules of interest in ozone research is presented. The experimental methods used to study the composition of the atmosphere generally can be divided into two types: those based respectively on in situ techniques and those based on remote sensing. The latter techniques use features related to the absorption and emission of electromagnetic radiation from the atmospheric molecules, such as the position and the intensity of the lines, their temperature and pressure dependence. As a result gas concentration, humidity, temperature, density, pressure, wind velocity, can be obtained. The spectral characteristics of about 40 molecular species (most of those present at measurable amounts in the atmosphere, except for N2 and O2) were considered. The spectral range is from about 200 nm to about 10 micrometers, and includes electronic and vibrational transitions of the molecules. The examined phenomena are absorption, emission, fluorescence, and phosphorescence. Papers related to photodissociation mechanisms are included since the spectra of the final products are often shown. ESA

**N93-17968#** Naval Postgraduate School, Monterey, CA.
**THE EFFECTS OF MIXED LAYER DYNAMICS ON ICE GROWTH IN THE CENTRAL ARCTIC M.S. Thesis**
Bruce R. Kitchen Sep. 1992 101 p
(AD-A257553) Avail: CASI HC A06/MF A02

The thermodynamic model of Thorndike (1992) is coupled to a one

dimensional, two layer ocean entrainment model to study the effect of mixed layer dynamics on ice growth and the variation in the ocean heat flux into the ice due to mixed layer entrainment. Model simulations show the existence of a negative feedback between the ice growth and the mixed layer entrainment, and that the underlying ocean salinity has a greater effect on the ocean beat flux than does variations in the underlying ocean temperature. Model simulations for a variety of surface forcings and initial conditions demonstrate the need to include mixed layer dynamics for realistic ice prediction in the arctic. GRA

**N93-18126#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**ANALYSIS AND COMPARISONS OF INVERTED MERIDIONAL WINDS FROM SPACE-BORNE MEASUREMENTS OF (OI) 5577A M.S. Thesis**
Patrick N. Purcell 1992 77 p
(AD-A258299) Avail: CASI HC A05/MF A01

This thesis provides a database comparison and analysis of daytime lower thermospheric (E-region) inverted meridional winds. This inversion technique was previously developed (Nardi, 1991) to retrieve the true wind at altitude from OI 5577 A measurements from the DE-2 Satellite's Fabry-Perot Interferometer. The inversion technique is briefly discussed in this study. The raw DE-2 satellite data is processed to obtain spectrograms. This data is processed further to obtain brightness and line-of-sight winds and wind errors. For daytime 5577 A emissions, these line-of-sight winds are averages over two emission layers. The purpose of the inversion technique is to 'unaverage' these winds through an onion peel method on the brightnesses and through a least squares fit to Chapman layers on the volume emission rates. GRA

**N93-18137#** Natural Environmental Research Council, Edinburgh (Scotland).
**MAGNETIC RESULTS 1987-89: LERWICK, ESKADALEMUIR, AND HARTLAND OBSERVATORIES (UNITED KINGDOM)**
D. J. Kerridge, comp., T. D. G. Clark, comp., and T. J. Harris, comp. 1991 336 p
(Geomagnetic-Bull-19; ISBN-0-85272-197-8; ETN-93-92996) Copyright Avail: CASI HC A15/MF A03

Measurements made from 1 Jan. 1987 - 31 Dec. 1989 at the United Kingdom geomagnetic observatories at Lerwick, Eskdalemuir, and Hartland are reported. The three observatory sites are described, with notes of any changes made during the year. A description of the Automatic Remote Geomagnetic Observatory System (ARGOS), deployed at each observatory since 1st Jan. 1987 is given. The method of collecting the data from each observatory, the quality control procedures, and the method of reducing the data to absolute values are outlined. The presentation of the data is principally in graphical form, with plots of daily and hourly mean values for each year, and complete sets of daily magnetograms derived from minute values. A diskette containing the hourly mean values, produced as a companion to this volume, is available on request. An annual report of the work carried out by the geomagnetism group during the year, in instrumentation and data proceessing techniques, is given. Some examples of the use of geomagnetic data in commerce and science are also given. ESA

**N93-18138#** Natural Environmental Research Council, Edinburgh (Scotland).
**MAGNETIC RESULTS 1990: LERWICK, ESKDALEMUIR, AND HARTLAND OBSERVATORIES (UNITED KINGDOM)**
T. D. G. Clark, comp., D. J. Kerridge, comp., and T. J. Harris, comp. 1992 142 p
(Geomagnetic-Bull-20; ISBN-0-85272-204-4; ETN-93-92997) Copyright Avail: CASI HC A07/MF A02

Measurements made from 1 Jan. - 31 Dec. 1990 at the United Kingdom geomagnetic observatories at Lerwick, Eskdalemuir, and Hartland are reported. The three observatory sites are described, with notes of any changes made during the year. A description of the Automatic Remote Geomagnetic Observatory System (ARGOS), deployed at each observatory since 1st Jan. 1987 is given. The method of collecting the data from each observatory, the quality control procedures, and the method of reducing the data to absolute values are outlined. The presentation of the data is principally in graphical form, with plots of daily and hourly mean values for each year, and complete sets of daily magnetograms derived from minute values. A diskette containing the hourly mean values, produced as a companion to this volume, is available on request. An annual report of the work carried out by the geomagnetism group during the year in instrumentation and data processing techniques is given. Some examples of the use of geomagnetic data in commerce and science are also given. ESA

**N93-18188** Politecnico di Milano (Italy). Dipartimento di Elettronica.
**REFLECTING MODEL: P-S ARRIVAL [METODO DELLA RIFLETTIVITA: ARRIVI P-S]**
G. Bernasconi and G. Drufuca 1992 23 p In ITALIAN
(Rept-92-029; ETN-93-93033) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

Seismic exploration is interested in combined observations of shear (S) and compressional (P) waves. The propagation of shear waves in elastic media and the inclusion of P-SV arrivals in the reflectivity method are analyzed. With this extension the reflectivity method can model all the components of the displacement in an horizontally layered medium, for sources of compressional waves with spherical symmetry. ESA

**N93-18212#** Naval Postgraduate School, Monterey, CA.
**A THEORY FOR WHISTLER WAVE AMPLIFICATION AND WAVE PARTICLE INTERACTIONS IN THE MAGNETOSPHERE M.S. Thesis**
Bernard M. Gately, Jr. Jun. 1992 69 p
(AD-A257782) Avail: CASI HC A04/MF A01

Whistler waves are a type of very low frequency (VLF) radiation which propagate through the earth's magnetosphere. This phenomenon can occur as a result of a lightning discharge and can be produced using ground-based VLF transmitters. It is theorized that these signals travel through ducts centered on geomagnetic field lines. While passing through these ducts the waves are amplified through resonant interaction with electrons in the radiation belts which are following helical paths around magnetic field lines. A description of whistlers and the related topic of VLF emissions is presented in Chapter 2, along with a description of how these effects change the properties of the ionosphere. Starting with the Lorentz force equation, the equations of motion for electrons in the magnetosphere are developed in Chapter 3. These equations are numerically integrated along with a wave equation developed in Chapter 4. The results of the simulation are presented in Chapter 5 for the idealized case of a monoenergetic beam of electrons. High and low gains in the wave amplitude are observed for both strong and weak initial VLF fields. The simulation is also run using distributions to represent the initial energies of the electrons in the radiation belts. Chapter 6 presents some possible ways to make the simulation more realistic along with a summary of the similarities between the theory presented and Free Electron Laser theory. GRA

**N93-18214#** Northeast Radio Observatory Corp., Westford, Mass. Haystack Observatory.
**RADAR-SATELLITE STUDIES OF THE HIGH-LATITUDE IONOSPHERE Final Report, 1 Aug. 1989 - 31 Aug. 1992**
John C. Foster 15 Oct. 1992 14 p
(Grant AF-AFOSR-0454-89)
(AD-A257918; AFOSR-92-0952TR) Avail: CASI HC A03/MF A01

Emphasis has been placed on the analysis of multi-instrument experiments investigating the physics of the auroral oval/polar cap boundary and the vicinity of the plasmapause and inner edge of the ring current at mid-latitudes utilizing existing data sets from Millstone Hill and other incoherent scatter radars and available satellite overflights and supporting ground-based information. Ionospheric signatures of the cusp and the mechanisms involved in large-scale plasma transport into the polar cap during magnetic storms have been investigated. Data from Air Force sensors on DMSP satellites have been combined with ground-based observations to examine intense oxygen ion outflow, localized intensifications of the convection electric field, and SAR arcs all of which occur equatorward of the main auroral enhancements during geomagnetic storms. The characteristics of the ring current and plasmasheet particle populations are closely coupled to these ionospheric phenomena. GRA

**N93-18320*#** Illinois Univ., Urbana. Dept. of Geology.
**EVOLUTION OF ATTACHED AND DETACHED SLABS AND THEIR ASSOCIATED MANTLE DYNAMICS Final Report, 4 Dec. 1992**
Albert T. Hsui 4 Dec. 1992 8 p

(Grant NAG5-1312)
(NASA-CR-191920; NAS 1.26:191920) Avail: CASI HC A02/MF A01

Over the two years of the NASA grant, this project has produced a significant amount of research results related to the plate subduction process and the surface crustal deformation at convergent boundaries (i.e., above subduction zones). While some research objectives are completely accomplished, other research tasks remain active and continue to be investigated at present. A steady state analytic thermal model for subducting slabs was used to examine the torques acting on a descending slab. It is found that gravitational torque vanishes when a slab is dipping either vertically or horizontally, unlike previous studies indicating that the magnitude of gravitational torque decreases as dip angle increases. Subsequently, a new time-dependent, analytic thermal model for a subducting slab was developed. The new model enables us to study transient phenomena associated with plate subduction analytically. On the basis of this model, the nature of slab dip angles was evaluated. Slab dip angles are found to be transient features. As they penetrate into the mantle and increase their lengths, the associated gravitational torque also increases resulting in a downward pulling of the slab to the steeper dip angle. This is especially true once a slab penetrates the olivine-spinel phase boundary at about 400 km depth. However, if the phase transformation does not follow the equilibrium condition, the gravitational torque may have a different behavior. This problem was investigated. Except for fast descending slabs, non-equilibrium phase transformation can only slow down the transient increase of slab dip angles discussed earlier. Its effect is not sufficiently strong to reverse the downward pulling for most of the slabs. However, when slabs subducting at 10 cm/yr or faster, a sufficient amount of metastable olivine can exist beneath 400 km. Because of its low density compared with the surrounding spinel, an upward buoyancy is produced resulting in an upward bending of the slab and possibly an upward rotation of the slab such that smaller dip angles are formed. Seismic studies of the Japanese Slab seem to support this interpretation. The development of oroclinal geometries at convergent boundaries was also examined to study plate obduction which is an important ingredient to the initiation of plate subduction. Although the study suggests that surface features are better modeled by block models, the large scale deformation can be adequately studied by viscous models. Such a model is now under development to complete our original objective to study the initiation of plate subduction. Finally, a three-dimensional, finite element, spherical convective model is developed to study dynamic plate subductions. The model development is now complete and it is being tested to ensure its proper operation. The model is able to generate convection results with a viscosity contrast of about 100. Our research continues to push the viscosity contrast to a level that is appropriate for a subducting slab. Author

**N93-18361*#** Michigan Univ., Ann Arbor. Space Physics Research Lab.
**VISIBLE AIRGLOW EXPERIMENT DATA ANALYSIS Final Technical Report, 1 Jul. 1983 - 30 Nov. 1989**
Vincent J. Abreu Aug. 1990 7 p
(Grant NAGw-496)
(NASA-CR-192119; NAS 1.26:192119) Avail: CASI HC A02/MF A01

The Visible Airglow Experiment (VAE) was designed to provide detailed profiles of the distribution of excited states of atoms and molecules in the upper atmosphere. The studies supported during the funding period (1983 - 1989) have made significant contributions in the area of thermospheric aeronomy, and the progress during the first four years of this period has been reviewed by Hays et al. (1988). The investigations carried out have resulted in more than 20 publications, and these are summarized. Author

**N93-18591*#** Harvard Coll. Observatory, Cambridge, MA. Center for Astrophysics.
**STUDIES OF REGIONAL AND GLOBAL TECTONICS AND THE ROTATION OF THE EARTH USING VERY-LONG-BASELINE INTERFEROMETRY Status Report, 1 Jun. 1991 - 31 May 1992**
Irwin I. Shapiro, J. X. Mitrovica, and James L. Davis 1992 21 p
(Grant NAG5-538)
(NASA-CR-191902; NAS 1.26:192902) Avail: CASI HC A03/MF A01

Work is continuing on the study of atmospheric gradients. We include a preprint entitled 'The effect of turbulence on atmospheric gradient parameters determined from ground-based radiometric and space geodetic measurements'. Work has begun on a study of solid Earth tidal deformations using the VLBI data set. We have examined deformations at the semi-diurnal tidal period using the IRIS data set. Author

**N93-18599*#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**IN SITU DETECTION OF TROPOSPHERIC OH, HO2, NO2, AND NO BY LASER-INDUCED FLUORESCENCE IN DETECTION CHAMBERS AT REDUCED PRESSURES Semiannual Progress Report, 1 Oct. 1991 - 30 Apr. 1992**
William H. Brune 6 Jul. 1992 14 p
(Grant NAG1-1057)
(NASA-CR-191916; NAS 1.26:191916) Avail: CASI HC A03/MF A01

This report is a brief summary of the status of work on the grant entitled 'In situ detection of tropospheric OH, HO2, NO2, and NO by laser induced fluorescence in detection chambers at low pressures'. The first version of the instrument is essentially complete and operational for about six months, and we continue to make improvements on the instrument sensitivity and reliability. We are focusing our efforts on improving our understanding of the operating characteristics of the instrument - particularly the inlet transmission for OH and HO2, the exact character of the air flow around and within the instrument, and the efficiency of the chemical conversion of HO2 to OH. We are also in the process of converting this laboratory instrument into a field worthy instrument that we can take to remote sites for measurements. Author

**N93-18606*#** Aerospace Corp., Los Angeles, CA.
**[EVALUATING AURORAL PROCESSES WITHIN A MAGNOTOSPHERIC MODEL] Final Report**
L. R. Lyons 1989 14 p
(Grant NAGw-853)
(NASA-CR-192122; NAS 1.26:192122) Avail: CASI HC A03/MF A01

A summary of the research performed is included. Topics covered include magnetospheric model; association between discrete auroras and ion precipitation from the tail current sheet; auroral arc scale sizes and structures; polar cap size variation; low-altitude auroral boundary; auroral wave-particle interactions; thermospheric interactions; and the neutral wind 'flywheel'. L.R.R.

**N93-18704*#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**HIGH-SPATIAL-RESOLUTION PASSIVE MICROWAVE SOUNDING SYSTEMS Progress Report, 1 Aug. 1990 - 31 Jan. 1991**
David H. Staelin, J. W. Barrett, Pierino Gianni Bonanni, W. J. Chiarchiaro, II, and P. W. Rosenkranz 2 Apr. 1991 8 p
(Grant NAG5-10)
(NASA-CR-192228; NAS 1.26:192228) Avail: CASI HC A02/MF A01

During this period the emphasis was on the following: (1) further design, construction, and testing of the improved 54-GHz portion of the 54-118 GHz microwave temperature sounder (MTS) aircraft radiometer system in preparation for ER-2 observations in July 1991; and (2) final analysis and documentation of procedures for detecting and analyzing thermal waves in our 118-GHz MTS imagery. In addition, we have new unpublished measurements of dry-air attenuation at frequencies of 54 to 66 GHz and over a temperature range of 280K to 326K; these measurements should enable us to improve further our atmospheric transmittance models. It was further noted that the proposed SSMIS conical-scanning microwave spectrometer on the military DMSP Block 5D-3 spacecraft designed to measure stratospheric and mesospheric temperature profiles will be observing the Zeeman-split oxygen lines with sufficient spectral resolution that the changing Doppler shifts with view angle will substantially degrade the potential system performance unless remedied; this was briefly studied and documented. Author

**N93-18736#** Oulu Univ. (Finland). Dept. of Physics.
**REPORT ON THE 7TH FINNISH EISCAT WORKSHOP [7. SUOMALAINEN EISCAT-TUTKIMUSSEMINAARI]**
Jorma Kangas, ed. Feb. 1992 103 p In ENGLISH and FINNISH Workshop held in Oulu, Finland, 17-18 Dec. 1991
(Rept-121-(1992); ISBN-951-42-3313-1; ETN-93-92171) Avail: CASI HC A06/MF A02

The activities of EISCAT, a radar used for ionospheric studies, in Finland in 1991 are addressed. Information on the orbits, instrumentation, data

storage capacity, and goals of satellites related to EISCAT is given. The Swedish Freja satellite, in particular, is addressed. Campaigns to study the northern lights are reported. The functioning of the ground station in the EISCAT northern lights campaign is addressed. A set of graphics illustrating a model of ionosphere-magnetosphere mesoscale coupling is presented. Results of EISCAT observations of spectral components of atmospheric gravity waves in the F region are presented. Finnish interests in the EISCAT radar and the Polar Cap Radar research are addressed. EISCAT educational programs are considered. A status report of GUISDAP (Ground Unified Incoherent Scatter Data Analysis Program) is given. The optimization of radar measurements is addressed. For individual titles, see N93-18737 through N93-18748.

**N93-18737#** Oulu Univ. (Finland). Dept. of Physics.
**REPORT ON THE 7TH FINNISH EISCAT WORKSHOP IN 1991 [EISCAT-TUTKIMUS SUOMESSA V 1991]**
Jorma Kangas *In its* Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 3-8 In FINNISH (For primary document see N93-18736 06-46)
Avail: CASI HC A02/MF A02

The activities of EISCAT, a radar used for ionospheric studies, in Finland in 1991 are summarized. Fifty eight hours of the EISCAT special program time was used for Finnish experiments. The total by the end of 1991 was about 420 hours, corresponding to about 4.8 percent of the EISCAT total. Details of 13 papers published or submitted for publication in 1991 are given. ESA

**N93-18738#** Finnish Meteorological Inst., Helsinki.
**EISCAT RELATED SATELLITES IN NEAR FUTURE**
Hannu Koskinen *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 9-12 (For primary document see N93-18736 06-46)
Avail: CASI HC A01/MF A02

Satellites related to EISCAT, a radar in northern Scandinavia for ionospheric studies, are discussed together with their country of manufacture and launch dates. The following satellites are listed: APEX (Active Plasma Experiments in the Earth's Magnetosphere), FAST (Fast Auroral Snapshot Explorer), Interball, Freja, Cluster, and Polar. Details of the orbits, instrumentation, data storage capacity, and goals of APEX, FAST, Interball, and Freja are given. ESA

**N93-18739#** Oulu Univ. (Finland). Dept. of Physics.
**FREJA SATELLITE PROGRAM AND ITS CONNECTION TO EISCAT**
Reijo Rasinkangas *In its* Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 13-17 (For primary document see N93-18736 06-46)
Avail: CASI HC A01/MF A02

The Freja satellite, to be launched in Oct. 1992, which will study small scale auroral structures, auroral particle acceleration at low altitudes, ion outflow from ionosphere, auroral arc systems, and auroral phenomena, is introduced. Details of the following are given: data distribution; instrumentation; campaigns; and data analysis in Oulu (Finland) and its connection to EISCAT, a radar in the Northern Hemisphere used for ionospheric studies. ESA

**N93-18740#** Oulu Univ. (Finland). Dept. of Physics.
**CAMPAIGNS TO STUDY THE AURORA BOREALIS FOCUSED ON MYRIAMETRIC WAVES IN 1991 [VLF-PAINOTTEISET REVONTULIKAMPANJAT VUONNA 1991]**
Jyrki Manninen *In its* Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 19-27 In FINNISH (For primary document see N93-18736 06-46)
Avail: CASI HC A02/MF A02

Three campaigns carried out in 1991 are reported, and despite certain technical difficulties numerous results are presented. The campaigns enabled the testing and improvement of materials and helped solve the problem of coordinating different recorders. The third campaign was particularly productive thanks to the use of EISCAT (a radar in the Northern Hemisphere for ionospheric study). The northern aurora studies were to be continued in 1992. ESA

**N93-18741#** Oulu Univ. (Finland). Dept. of Physics.
**GROUND STATION OPERATION IN THE EISCAT CAMPAIGN FOCUSED ON THE AURORA BOREALIS IN NOVEMBER 1991 [MAANPINTA-ASEMAN TOIMINTA REVONTULIPAINOTTEISEN EISCAT-KAMPANJAN YHTEYDESSAE MARRASKUUSSA 1991]**
Jyrki Manninen *In its* Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 29-30 In FINNISH (For primary document see N93-18736 06-46)
Avail: CASI HC A01/MF A02

Factors contributing to the choice of position of the ground station are listed and the dates of exploitable measurements carried out and recorded on video are noted. Reasons which made the measurements difficult to carry out are listed. Details of the measuring instruments, recording apparatus, communication equipment, modes of transport, observatory, and other notable equipment are given. The number of personnel and the cost of the campaign are addressed. ESA

**N93-18742#** Finnish Meteorological Inst., Helsinki. Geophysics Dept.
**SIMULATION OF IONOSPHERE-MAGNETOSPHERE MESOSCALE COUPLING: LETTING IONOSPHERIC CONDUCTIVITIES DEPEND ON UPWARD FIELD-ALIGNED CURRENTS**
Pekka Janhunen *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 31-39 (For primary document see N93-18736 06-46)
Avail: CASI HC A02/MF A02

A set of graphics illustrating a model of ionosphere-magnetosphere mesoscale coupling is presented. It is seen that rather complicated structures emerge even though the magnetospheric input is vey simple. The dependence of conductivities on field aligned currents is concluded to be very important. It is noted that the model described can be economically integrated on modern (super)computers. ESA

**N93-18743#** Oulu Univ. (Finland). Dept. of Physics.
**EISCAT OBSERVATIONS OF SPECTRAL COMPONENTS OF ATMOSPHERIC GRAVITY WAVES IN THE F REGION**
T. Nygren and B. S. Lanchester (Southampton Univ., England ) *In its* Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 41-47 (For primary document see N93-18736 06-46)
Avail: CASI HC A02/MF A02

Results of a continuation of 1991 observations of several frequency components in the gravity wave spectrum and investigations of their manifestations in sporadic E are presented. The various spectral components are separated using digital filtering and their propagation in the presence of atmospheric background wind with a vertical shear is studied using the Hines dispersion equation. The parallel phase velocity and the period of gravity wave is obtained from the EISCAT (a radar in Northern Hemisphere used for ionospheric studies) observation, which also gives the meridional neutral wind. The approximate direction of gravity wave propagation (southwards) is deduced from the dynasonde data and an atmospheric model is used in determining the height profiles of the cutoff frequencies needed in the Hines dispersion equation. The results give both horizontal and vertical phase speeds and wavelengths of the various spectral components. The results are preliminary. ESA

**N93-18744#** Geophysical Observatory, Sodankyla (Finland).
**EISCAT SVALBARD RADAR** **c32**
Markku Lehtinen and Jorma Kangas (Oulu Univ., Finland ) *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 49-64 (For primary document see N93-18736 06-46)
Avail: CASI HC A03/MF A02

The main fields of interest of the Finnish scientists in EISCAT research are listed. Finnish interests in the Polar Cap Radar (PMR) and areas where the Finnish contribution could be important are addressed: radar techniques; sporadic E layers in the polar cap; atmospheric models; auroral studies in the polar cap; nonthermal plasmas in the F region; coordinated measurements with the Cluster satellites; studies of the ionospheric traveling; convection vortices; polar cap absorption; studies of lower atmosphere; educational program. A report on the design specification of an ionospheric and atmospheric radar facility based on the archipelago of Svalbard (Norway) is summarized. ESA

**N93-18745#** Oulu Univ. (Finland). Dept. of Physics.
**EISCAT EDUCATIONAL PROGRAMS** **c80**
Jorma Kangas *In its* Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 65-69 (For primary document see N93-18736 06-46)
Avail: CASI HC A01/MF A02

Two proposals to intensify the educational programs which are relevant to the EISCAT (radar in northern Scandinavia for ionospheric studies) research are presented: the EISCAT summer school to be organized in Finland in 1993 and the EISCAT postgraduate program in the frame of the ERASMUS (European Community Action Scheme for the Mobility of University Students) exchange program. The promotion of the EISCAT program by ERASMUS and the way to proceed are addressed. ESA

**N93-18746#** Finnish Meteorological Inst., Helsinki.
**GUISDAP Status Report** **c61**
Asko Huuskonen *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 71-78 (For primary document see N93-18736 06-46)
Avail: CASI HC A02/MF A02

GUISDAP (Grand Unified Incoherent Scatter Data Analysis Program) is outlined through a set of flow diagram graphics. The input variables from EISCAT data are shown. These variables form the GUISDAP experiment specifications. The history of GUISDAP versions and workshops is shown. ESA

**N93-18747#** Geophysical Observatory, Sodankyla (Finland).
**ON OPTIMIZATION OF RADAR MEASUREMENTS** **c32**
Markku Lehtinen *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 79-92 (For primary document see N93-18736 06-46)
Avail: CASI HC A03/MF A02

Bibliographies of literature about inverse problems and radar applications are given. The statistical inverse theory is outlined and both a nonlinear example with Gaussian errors and a linear example are given. The theory of measurements, a mathematical theory for comparison of different experiments, is defined and applied to linear Gaussian measurements. Radar measurement as an inverse problem is addressed and the object of optimization considered. Inputs and outputs of GUISDAP (Ground Unified Incoherent Scatter Data Analysis Program) are given together with the strong points of this program. ESA

**N93-18748#** Geophysical Observatory, Sodankyla (Finland).
**APPLICATIONS OF THEORY OF EXPERIMENTS TO IS MEASUREMENTS** **c32**
Markku Lehtinen *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 93-102 (For primary document see N93-18736 06-46)
Avail: CASI HC A02/MF A02

A set of graphics addressing the optimization of radar codes and data storage are presented, and guidelines for data analysis of Incoherent Scattering (IS) are given. The GURSIP (Grand Unified Radar Signal Processor) is addressed together with its applications. Details of the GURSIP analysis speed and decoding speed are given. ESA

**N93-18773*#** Alabama Univ., Huntsville. Dept. of Chemistry.
**CHEMICAL RELEASE AND RADIATION EFFECTS SATELLITE (CRRES) PROGRAM ARCHIVING AND PUERTO RICAN SOUNDING ROCKET CAMPAIGN Final Report, 11 Feb. - 10 Oct. 1992**
George P. Miller 10 Oct. 1992 13 p
(Contract NAS8-38609)
(NASA-CR-184503; NAS 1.26:184503) Avail: CASI HC A03/MF A01

The tasks undertaken as part of this contract included the continued coordination and documentation of the CRRES program and the development of an archive that details, in easily accessible form, the experimental results obtained by the CRRES Program. Details of the work undertaken and results achieved are summarized in the following sections. The achievement of this goal is clearly demonstrated in the appendices attached to this report and the success, in both scientific and public relation terms, of the El Coqui rocket campaign. Author

**N93-18850*#** Stanford Univ., CA. STAR Lab.
**A DE-1/WHISTLER STUDY OF THE THERMAL PLASMA STRUCTURE AND DYNAMICS IN THE DUSK BULGE SECTOR OF THE MAGNETOSPHERE Final Technical Report, 1 Aug. 1989 - 1 Oct. 1992**
D. L. Carpenter 1 Oct. 1992 17 p
(Grant NAG8-784)
(NASA-CR-192088; NAS 1.26:192088) Avail: CASI HC A03/MF A01

The objective of this research was to obtain new understanding of the thermal plasma structure and dynamics of the plasmasphere bulge region of the magnetosphere, with special emphasis on the erosion process that results in a reduction in plasmasphere size and on the manner in which erosion leads to the presence of patches of dense plasma in the middle and outer afternoon-dusk magnetosphere. Case studies involving data from the DE 1, GEOS 2, and ISEE 1 satellites and from ground whistler stations Siple, Halley, and Kerguelen were used. A copy of the published paper entitled 'A case study of plasma structure in the dusk sector associated with enhanced magnetospheric convection,' is included. Author

**N93-18962*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**ORBITAL, ROTATIONAL, AND CLIMATIC INTERACTIONS**
Bruce G. Bills, ed. Washington Dec. 1992 119 p Workshop held in Baltimore, MD, 9-11 Jul. 1991
(NASA-CP-3185; Rept-93B00004; NAS 1.55:3185) Avail: CASI HC A06/MF A02

The report of an international meeting on the topic of Orbital, Rotational, and Climatic Interactions, which was held 9-11 Jul. 1991 at the Johns Hopkins University is presented. The meeting was attended by 22 researchers working on various aspects of orbital and rotational dynamics, paleoclimate data analysis and modeling, solid-Earth deformation studies, and paleomagnetic analyses. The primary objective of the workshop was to arrive at a better understanding of the interactions between the orbital, rotational, and climatic variations of the Earth. This report contains a brief introduction and 14 contributed papers which cover most of the topics discussed at the meeting. For individual titles, see N93-18963 through N93-18976.

**N93-18963*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**GEODYNAMIC CONTRIBUTIONS TO GLOBAL CLIMATIC CHANGE** **c45**
Bruce G. Bills *In its* Orbital, Rotational and Climatic Interactions Dec. 1992 p 1-33 (For primary document see N93-18962 06-46)
Avail: CASI HC A03/MF A02

Orbital and rotational variations perturb the latitudinal and seasonal pattern of incident solar radiation, producing major climatic change on time scales of 10(exp 4)-10(exp 6) years. The orbital variations are oblivious to internal structure and processes, but the rotational variations are not. A program of investigation whose objective would be to explore and quantify three aspects of orbital, rotational, and climatic interactions is described. An important premise of this investigation is the synergism between geodynamics and paleoclimate. Better geophysical models of precessional dynamics are needed in order to accurately reconstruct the radiative input to climate models. Some of the paleoclimate proxy records contain information relevant to solid Earth processes, on time scales which are difficult to constrain otherwise. Specific mechanisms which will be addressed include: (1) climatic consequences of deglacial polar motion; and (2) precessional and climatic consequences of glacially induced perturbations in the gravitational oblateness and partial decoupling of the mantle and core. The approach entails constructing theoretical models of the rotational, deformational, radiative, and climatic response of the Earth to known orbital perturbations, and comparing these with extensive records of paleoclimate proxy data. Several of the mechanisms of interest may participate in previously unrecognized feed-back loops in the climate dynamics system. A new algorithm for estimating climatically diagnostic locations and seasons from the paleoclimate time series is proposed. Author

**N93-18964*#** Bureau des Longitudes, Paris (France).
**PRECESSIONAL QUANTITIES FOR THE EARTH OVER 10 MYR**
Jacques Laskar *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 35-40 (For primary document see N93-18962 06-46)
Avail: CASI HC A02/MF A02

The insolation parameters of the Earth depend on its orbital parameters and on the precession and obliquity. Until 1988, the usually adopted solution for paleoclimate computation consisted in (Bretagnon, 1974) for the orbital elements of the Earth, which was completed by (Berger, 1976) for the computation of the precession and obliquity of the Earth. In 1988, I issued a solution for the orbital elements of the Earth, which was obtained in a new manner, gathering huge analytical computations and numerical integration (Laskar, 1988). In this solution, which will be denoted La88, the precession and obliquity quantities necessary for paleoclimate computations were integrated at the same time, which insure good consistency of the solutions. Unfortunately, due to various factors, this latter solution for the precession and obliquity was not widely distributed (Berger, Loutre, Laskar, 1988). On the other side, the orbital part of the solution La88 for the Earth, was used in (Berger and Loutre, 1991) to derive another solution for precession and obliquity, aimed to climate computations. I also issued a new solution (La90) which presents some slight improvements with respect to the previous one (Laskar, 1990). As previously, this solution contains orbital, precessional, and obliquity variables. The main features of this new solution are discussed. Author

**N93-18965*#** Cincinnati Univ., OH. Dept. of Aerospace Engineering.
**NUMERICAL INVESTIGATION OF THE EARTH'S ROTATION DURING A COMPLETE PRECESSION CYCLE**
David L. Richardson *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 41-44 (For primary document see N93-18962 06-46)
Avail: CASI HC A01/MF A02

A theory for the long-term rotational motion of the quasi-rigid Earth was constructed by numerical integration. The theory spans 72,000 years centered about 1968 A.D., and provides accurate rotational and positional data for the Earth in the recent past and the near future. The physical model is termed dynamically consistent because developments for the active forces and torques are truncated based solely on their magnitudes regardless of their origin. The model includes all appropriate forces and torques due to the geopotential and tidal effects as well as lunisolar and planetary contributions. The elastic and inelastic deformations due to tidal action were too small to affect the mass properties of the Earth at the truncation level of the model. However, long-term dissipative effects of the tidal forces and torques were not negligible. These considerations gave the model its quasi-rigid characterization. The numerical output provided both rotational and orbital-element data. The data were fitted throughout the 72,000-year range using Chebyshev polynomial series. Author

**N93-18966*#** Universite Catholique de Louvain (Belgium). Inst. d'Astonomie et Geophysique.
**VARIATIONS OF THE MILANKOVITCH FREQUENCIES IN TIME**
Marie-France Loutre and A. Berger *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 45-48 (For primary document see N93-18962 06-46)
Avail: CASI HC A01/MF A02

The sensitivity of the amplitudes and frequencies in the development of the Earth's orbital and rotational elements involved in the astronomical theory of paleoclimates (eccentricity, obliquity, and climate precession), to the Earth-Moon distance and consequently to the length of the day and to the dynamical ellipticity of the Earth has been discussed for the last billions of years. The shortening of the Earth-Moon distance and of the length of the day, as well as the lengthening of the dynamical ellipticity of the Earth back in time induce a shortening of the fundamental astronomical periods for precession and obliquity. At the same time, the amplitudes of the different terms in the development of the obliquity are undergoing a relative enlargement of about 50 percent at 2 x 10(exp 9) yr BP but the independent term is increasing very weakly (less than 0.1 percent). In other words, the value of the obliquity, which lies within a range of 21.7 to 24.9 deg over the Quarternary was restricted to a range of 22.5 to 24.1 deg at 2 x 10(exp 9) yr BP. On the other hand, the amplitudes in the development of the climatic precession do not change. Moreover, these changes in the frequencies and amplitudes for both obliquity and climatic precession are larger for longer period terms. Finally, the periods in the eccentricity development are not influenced by the variation of the lunar distance. But the motion of the solar system, especially of the inner planets, was shown to be chaotic. It means that it is impossible to compute the exact motion of the planets over more than about 100 Myr, and the fundamental frequencies of the systems are not fixed quantities, but are slowly varying with time. As long as we consider the most important terms, the maximum deviation from the present-day value of the 19-kyr precessional period due to the chaotic motion of the solar system only does not reach more than a few tens of years around 80 Myr BP. Therefore the shortening of the obliquity and climatic precession periods is mostly driven by the change in the lunar distance and the consequent variations in the dynamical ellipticity of the Earth's angular speed. At first sight, the deviation in the period for the eccentricity can be neglected, as the chaotic behavior of the solar system implies a relative change of the main periods by less than 0.2 percent, 1.4 percent, and 1.9 percent respectively, this maximum change being achieved around 80 Myr BP. This implies, in particular, that the eccentricity periods for Quarternary climate studies may be considered more or less constant for pre-Quaternay times and equal to their Quaternary values. Author

**N93-18967*#** California Univ., Davis. Dept. of Geology.
**MAGNETIC SUSCEPTIBILITY VARIATIONS IN LOESS SEQUENCES AND THEIR RELATIONSHIP TO ASTRONOMICAL FORCING**
Kenneth L. Verosub and Michael J. Singer *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 49-58 (For primary document see N93-18962 06-46)
Avail: CASI HC A02/MF A02

The long, well-exposed and often continuous sequences of loess found throughout the world are generally thought to provide an excellent opportunity for studying long-term, large-scale environmental change during the last few million years. In recent years, the most fruitful loess studies have been those involving the deposits of the loess in China. One of the most intriguing results of that work has been the discovery of an apparent correlation between variations in the magnetic susceptibility of the loess sequence and the oxygen isotope record of the deep sea. This correlation implies that magnetic susceptibility variations are being driven by astronomical parameters. However, the basic data have been interpreted in various ways by different authors, most of whom assumed that the magnetic minerals in the loess have not been affected by post-depositional processes. Using a chemical extraction procedure that allows us to separate the contribution of secondary pedogenic magnetic minerals from primary inherited magnetic minerals, we have found that the magnetic susceptibility of the Chinese paleosols is largely due to a pedogenic component which is present to a lesser degree in the loess. We have also found that the smaller inherited component of the magnetic susceptibility is about the same in the paleosols and the loess. These results demonstrate the need for additional study of the processes that create magnetic susceptibility variations in order to interpret properly the role of astronomical forcing in producing these variations. Author

**N93-18968*#** Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
**ICE AGES AND GEOMAGNETIC REVERSALS**
Patrick Wu *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 59-65 (For primary document see N93-18962 06-46)
Avail: CASI HC A02/MF A02

There have been speculations on the relationship between climatic cooling and polarity reversals of the earth's magnetic field during the Pleistocene. Two of the common criticisms on this relationship have been the reality of these short duration geomagnetic events and the accuracy of their dates. Champion et al. (1988) have reviewed recent progress in this area. They identified a total of 10 short-duration polarity events in the last 1 Ma and 6 of these events have been found in volcanic rocks, which also have K-Ar dates. Supposing that the speculated relationship between climatic cooling and geomagnetic reversals actually exist, two mechanisms that assume climatic cooling causes short period magnetic reversals will be investigated. These two methods are core-mantle boundary topography and transfer of the rotational energy to the core. Author

**N93-18969*#** Brown Univ., Providence, RI. Dept. of Geological Sciences.
**LATE QUATERNARY TIME SERIES OF ARABIAN SEA PRODUCTIVITY: GLOBAL AND REGIONAL SIGNALS**
Steven C. Clemens, W. L. Prell, and D. W. Murray *In* NASA. Goddard

Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 67-74 (For primary document see N93-18962 06-46)
Avail: CASI HC A02/MF A02

Modern annual floral and faunal production in the northwest Arabian Sea derives primarily from upwelling induced by strong southwest winds during June, July, and August. Indian Ocean summer monsoon winds are, in turn, driven by differential heating between the Asian continent and the Indian ocean to the south. This differential heating produces a strong pressure gradient resulting in southwest monsoon winds and both coastal and divergent upwelling off the Arabian Peninsula. Over geologic time scales (10(exp 4) to 10(exp 6) years), monsoon wind strength is sensitive to changes in boundary conditions which influence this pressure gradient. Important boundary conditions include the seasonal distribution of solar radiation, global ice volume, Indian Ocean sea surface temperature, and the elevation and albedo of the Asian continent. To the extent that these factors influence monsoon wind strength, they also influence upwelling and productivity. In addition, however, productivity associated with upwelling can be decoupled from the strength of the summer monsoon winds via ocean mechanisms which serve to inhibit or enhance the nutrient supply in the intermediate waters of the Indian Ocean, the source for upwelled waters in the Arabian Sea. To differentiate productivity associated with wind-induced upwelling from that associated with other components of the system such as nutrient sequestering in glacial-age deep waters, we employ a strategy which monitors independent components of the oceanic and atmospheric subsystems. Using sediment records from the Owen Ridge, northwest Arabian Sea, we monitor the strength of upwelling and productivity using two independent indicators, percent G. bulloides and opal accumulation. We monitor the strength of southwest monsoon winds by measuring the grain-size of lithogenic dust particles blown into the Arabian Sea from the surrounding deserts of the Somali and Arabian Peninsulas. Our current hypothesis is that the variability associated with the 41 kyr power in the G. bulloides and opal accumulation records derive from nutrient availability in the intermediate waters which are upwelled via monsoon winds. This hypothesis is testable by comparison with Cd records of intermediate and deep waters of the Atlantic and Indian Ocean. Author

**N93-18970*#** Lamont-Doherty Geological Observatory, Palisades, NY.
**ANNUAL, ORBITAL, AND ENIGMATIC VARIATIONS IN TROPICAL OCEANOGRAPHY RECORDED BY THE EQUATORIAL ATLANTIC AMPLIFIER Abstract Only**
Andrew McIntyre (Queens Coll., Flushing, NY.) *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 7 (For primary document see N93-18962 06-46)
Avail: CASI HC A01/MF A02

Equatorial Atlantic surface waters respond directly to changes in zonal and meridional lower tropospheric winds forced by annual insolation. This mechanism has its maximum effect along the equatorial wave guide centered on 10 deg W. The result is to amplify even subtle tropical climate changes such that they are recorded by marked amplitude changes in the proxy signals. Model realizations, NCAR AGCM and OGCM for 0 Ka and 126 Ka (January and July), and paleoceanographic proxy data show that these winds are also forced by insolation changes at the orbital periods of precession and obliquity. Perhelion in boreal summer produces a strengthened monsoon, e.g., increase meridional and decrease zonal wind stress. This reduces oceanic Ekman divergence and thermocline/nutricline shallowing. The result, in the equatorial Atlantic, is reduced primary productivity and higher euphotic zone temperatures; vice versa for perihelion in boreal winter. Perihelion is controlled by precession. Thus, the dominant period in spectra from a stacked SST record (0-252 Ka BP) at the site of the equatorial Atlantic amplifier is 23 Ky (53 percent of the total variance). This precessional period is coherent (k = 0.920) and in phase with boreal summer insolation. Oscillations of shorter period are present in records from cores sited beneath the amplifier region. These occur between 12.5 and 74.5 Ka BP, when eccentricity modulation of precession is at a minimum. Within this time interval there are 21 cycles with mean periods of 3.0 plus or minus 0.5 Ky. Similar periods have been documented from high latitude regions, e.g., Greenland ice cores from Camp Century. The Camp Century signal in this same time interval contains 21 cycles. A subjective correlation was made between the Camp Century and the equatorial records; the signals were statistically similar, r = 0.722 and k = 0.960. Author

**N93-18971*#** Applied Research Corp., College Station, TX.
**MODELING ORBITAL CHANGES ON TECTONIC TIME SCALES Abstract Only**
Thomas J. Crowley *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 7 (For primary document see N93-18962 06-46)
Avail: CASI HC A01/MF A02

Geologic time series indicate significant 100 ka and 400 ka pre-Pleistocene climate fluctuations, prior to the time of such fluctuations in Pleistocene ice sheets. The origin of these fluctuations must therefore depend on phenomena other than the ice sheets. In a previous set of experiments, we tested the sensitivity of an energy balance model to orbital insolation forcing, specifically focusing on the filtering effect of the Earth's geography. We found that in equatorial areas, the twice-yearly passage of the sun across the equator interacts with the precession index to generate 100 ka and 400 ka power in our modeled time series. The effect is proportional to the magnitude of land in equatorial regions. We suggest that such changes may reflect monsoonal variations in the real climate system, and the subsequent wind and weathering changes may transfer some of this signal to the marine record. A comparison with observed fluctuations of Triassic lake levels is quite favorable. A number of problems remain to be studied or clarified: (1) the EBM experiments need to be followed up by a limited number of GCM experiments; (2) the sensitivity to secular changes in orbital forcing needs to be examined; (3) the possible modifying role of sedimentary processes on geologic time series warrants considerably more study; (4) the effect of tectonic changes on Earth's rotation rate needs to be studied; and (5) astronomers need to make explicit which of their predictions are robust and geologists and astronomers have to agree on which of the predictions are most testable in the geologic record. Author

**N93-18972*#** Yale Univ., New Haven, CT. Dept. of Geology and Geophysics.
**PLIO-PLEISTOCENE TIME EVOLUTION OF THE 100-ky CYCLE IN MARINE PALEOCLIMATE RECORDS**
Jeffrey Park and Kirk A. Maasch *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 79-87 (For primary document see N93-18962 06-46)
Avail: CASI HC A02/MF A02

To constrain theories for the dynamical evolution of global ice mass through the late Neogene, it is important to determine whether major changes in the record were gradual or rapid. Of particular interest is the evolution of the near 100-ky ice age cycle in the middle Pleistocene. We have applied a new technique based on multiple taper spectrum analysis which allows us to model the time evolution of quasi-periodic signals. This technique uses both phase and amplitude information, and enables us to address the question of abrupt versus gradual onset of the 100-ky periodicity in the middle Pleistocene. Author

**N93-18973*#** Yale Univ., New Haven, CT. Dept. of Geology and Geophysics.
**A FIRST-ORDER GLOBAL MODEL OF LATE CENOZOIC CLIMATIC CHANGE: ORBITAL FORCING AS A PACEMAKER OF THE ICE AGES**
Barry Saltzman *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 89-94 (For primary document see N93-18962 06-46)
Avail: CASI HC A02/MF A02

The development of a theory of the evolution of the climate of the earth over millions of years can be subdivided into three fundamental, nested, problems: (1) to establish by equilibrium climate models (e.g., general circulation models) the diagnostic relations, valid at any time, between the fast-response climate variables (i.e., the 'weather statistics') and both the prescribed external radiative forcing and the prescribed distribution of the slow response variables (e.g., the ice sheets and shelves, the deep ocean state, and the atmospheric CO2 concentration); (2) to construct, by an essentially inductive process, a model of the time-dependent evolution of the slow-response climatic variables over time scales longer than the damping times of these variables but shorter than the time scale of tectonic changes in the boundary conditions (e.g., altered geography and elevation of the continents, slow outgassing, and weathering) and ultra-slow astronomical changes such as in the solar radiative output; and (3) to determine the nature of these ultra-slow processes and their effects on

the evolution of the equilibrium state of the climatic system about which the above time-dependent variations occur. All three problems are discussed in the context of the theory of the Quaternary climate, which will be incomplete unless it is embedded in a more general theory for the fuller Cenozoic that can accommodate the onset of the ice-age fluctuations. We construct a simple mathematical model for the Late Cenozoic climatic changes based on the hypothesis that forced and free variations of the concentration of atmospheric greenhouse gases (notably CO2), coupled with changes in the deep ocean state and ice mass, under the additional 'pacemaking' influence of earth-orbital forcing, are primary determinants of the climate state over this period. Our goal is to illustrate how a single model governing both very long term variations and higher frequency oscillatory variations in the Pleistocene can be formulated with relatively few adjustable parameters. Author

**N93-18974*#** California Univ., Los Angeles. Dept. of Geological Sciences.

**THE ORBITAL RECORD IN STRATIGRAPHY**

Alfred G. Fischer *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 95-112 (For primary document see N93-18962 06-46)

Avail: CASI HC A03/MF A02

Orbital signals are being discovered in pre-Pleistocene sediments. Due to their hierarchical nature these cycle patterns are complex, and the imprecision of geochronology generally makes the assignment of stratigraphic cycles to specific orbital cycles uncertain, but in sequences such as the limnic Newark Group under study by Olsen and pelagic Cretaceous sequence worked on by our Italo-American group the relative frequencies yield a definitive match to the Milankovitch hierarchy. Due to the multiple ways in which climate impinges on depositional systems, the orbital signals are recorded in a multiplicity of parameters, and affect different sedimentary facies in different ways. In platform carbonates, for example, the chief effect is via sea-level variations (possibly tied to fluctuating ice volume), resulting in cycles of emergence and submergence. In limnic systems it finds its most dramatic expression in alternations of lake and playa conditions. Biogenic pelagic oozes such as chalks and the limestones derived from them display variations in the carbonate supplied by planktonic organisms such as coccolithophores and foraminifera, and also record variations in the aeration of bottom waters. Whereas early studies of stratigraphic cyclicity relied mainly on bedding variations visible in the field, present studies are supplementing these with instrumental scans of geochemical, paleontological, and geophysical parameters which yield quantitative curves amenable to time-series analysis; such analysis is, however, limited by problems of distorted time-scales. My own work has been largely concentrated on pelagic systems. In these, the sensitivity of pelagic organisms to climatic-oceanic changes, combined with the sensitivity of botton life to changes in oxygen availability (commonly much more restricted in the Past than now) has left cyclic patterns related to orbital forcing. These systems are further attractive because (1) they tend to offer depositional continuity, and (2) presence of abundant microfossils yields close ties to geochronology. A tantalizing possibility that stratigraphy may yield a record of orbital signals unrelated to climate has turned up in magnetic studies of our Cretaceous core. Magnetic secular variations here carry a strong 39 ka periodicity, corresponding to the theoretical obliquity period of that time - Does the obliquity cycle perhaps have some direct influence on the magnetic field? Author

**N93-18975*#** Lamont-Doherty Geological Observatory, Palisades, NY.

**EVIDENCE OF ORBITAL FORCING IN 510 TO 530 MILLION YEAR OLD SHALLOW MARINE CYCLES, UTAH AND WESTERN CANADA Abstract Only**

Gerard C. Bond, John Beavan, Michelle A. Kominz (Texas Univ., Austin.), and William Devlin (Exxon Production Research Company, Houston, TX.) *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 113-114 (For primary document see N93-18962 06-46)

Avail: CASI HC A01/MF A02

Spectral analyses of two sequences of shallow marine sedimentary cycles that were deposited between 510 and 530 million years ago were completed. One sequence is from Middle Cambrian rocks in southern Utah and the other is from Upper Cambrian rocks in the southern Canadian Rockies. In spite of the antiquity of these strata, and even though there are differences in the age, location, and cycle facies between the two sequences, both records have distinct spectral peaks with surprisingly similar periodicities. A null model constructed to test for significance of the spectral peaks and circulatory in the methodology indicates that all but one of the spectral peaks are significant at the 90 percent confidence level. When the ratios between the statistically significant peaks are measured, we find a consistent relation to orbital forcing; specifically, the spectral peak ratios in both the Utah and Canadian examples imply that a significant amount of the variance in the cyclic records is driven by the short eccentricity (approximately 109 ky) and by the precessional (approximately 21 ky) components of the Earth's orbital variations. Neither section contains a significant component of variance at the period of the obliquity cycle, however. Author

**N93-18976*#** Johns Hopkins Univ., Baltimore, MD. Dept. of Earth and Planetary Sciences.

**THE CYCLIC CARBONATES OF THE LATEMAR MASSIF: EVIDENCE FOR THE ORBITAL FORCING OF A CARBONATE PLATFORM DURING THE MIDDLE TRIASSIC Abstract Only**

Linda Hinnov *In* NASA. Goddard Space Flight Center, Orbital, Rotational and Climatic Interactions Dec. 1992 p 115 (For primary document see N93-18962 06-46)

Avail: CASI HC A01/MF A02

The Latemar Massif is an exhumed carbonate platform in the Dolomites of Northern Italy that was deposited during the Ladinian stage of the Middle Triassic. The platform interior is comprised of hundreds of vertically stacked, meter scale, subtidal limestone/vadose cap carbonate cycles ('Latemar couplets') arranged into upward thinning bundles of 5. The individual couplets are interpreted as the products of sea level oscillations occurring with an approximately 20,000 year periodicity; the 5:1 bundling is indicative of a lower order approximately 100,000 year modulating component. This combination of cycling is interpreted as a platform response to precession forcing with the 5:1 bundling an expression of modulation by the eccentricity. Spectral analysis confirms the significance of the 5:1 bundling, and identifies other significant bundling components related to other components of the eccentricity. The results show that the Latemar bundling spectrum is complex, with a splitting of components around the 1 percent bundling frequency, suggestive of the multiple component eccentricity in the 100,000 year range. On the other hand, there is no direct evidence for the major 400,000 year eccentricity component, although there is a dominant approximately 700,000 year cycling in the buildup (a 35:1 bundling period). Other higher frequency bundling components may be related to obliquity forcing. Simple models are presented to argue for and against an astronomical origin of these cyclic platform carbonates. Author

**N93-19036*#** Georgia Inst. of Tech., Atlanta. School of Electrical Engineering.

**INVESTIGATION OF PASSIVE ATMOSPHERIC SOUNDING USING MILLIMETER AND SUBMILLIMETER WAVELENGTH CHANNELS**

**Semiannual Status Report No. 4, 1 Jul. - 31 Dec. 1992**

Albin J. Gasiewski, L. K. Adelberg, D. B. Kunkee, and D. M. Jackson 23 Feb. 1993 36 p

(Grant NAG5-1490)

(NASA-CR-192305; NAS 1.26:192305) Avail: CASI HC A03/MF A01

Activities within the period from July 1, 1992 through December 31, 1992 by Georgia Tech researchers in millimeter and submillimeter wavelength tropospheric remote sensing have been centered around the calibration of the Millimeter-wave Imaging Radiometer (MIR), preliminary flight data analysis, and preparation for TOGA/COARE. The MIR instrument is a joint project between NASA/GSFC and Georgia Tech. In the current configuration, the MIR has channels at 90, 150, 183(+/-1,3,7), and 220 GHz. Provisions for three additional channels at 325(+/-1,3) and 8 GHz have been made, and a 325-GHz receiver is currently being built by the ZAX Millimeter Wave Corporation for use in the MIR. Past Georgia Tech contributions to the MIR and its related scientific uses have included basic system design studies, performance analyses, and circuit and radiometric load design, in-flight software, and post-flight data display software. The combination of the above millimeter wave and submillimeter wave channels aboard a single well-calibrated instrument will provide unique radiometric data for radiative transfer and cloud and water vapor retrieval studies. A paper by the PI discussing the potential benefits of passive millimeter and submillimeter

wave observations for cloud, water vapor and precipitation measurements has recently been published, and is included as an appendix. Author

**N93-19071#** ENSCO, Inc., Springfield, VA.
**EVALUATION OF REGIONAL SEISMIC DISCRIMINANTS USING THE INTELLIGENT SEISMIC EVENT IDENTIFICATION SYSTEM Semiannual Report**
Douglas Baumgardt, Jeanne Carney, Michael Maxson, and Sam Carter 23 Oct. 1992 103 p
(Contract F29601-92-C-0009; ARPA Order 6731)
(AD-A258936; SAS-TR-93-38) Avail: CASI HC A06/MF A02

In this study, the effectiveness of several regional waveform discriminants and processing methods are being evaluated using a large database of regional waveforms. ISEIS was installed at the Center for Seismic Studies (CSS) where it is being used to process and analyze discriminants for seismic events formed by the Intelligent Monitoring System (IMS). The system has undergone a number of modifications to interface with the CSS databases and to improve the processing efficiency of the system in the CSS environment. Also, a number of new features were added to facilitate the processing of the data and discrimination research, including automated feature extraction and processing, improved plotting displays for reviewing IMS and analyst phase identification, data viewing displays for reference events plotted in scatterplots, a new top-level display for viewing ISEIS processing results, multichannel coherence and deconvolution processing interfaces, and a research interface for multivariate classification using a simulated neural network approach. GRA

**N93-19791#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**ATMOSPHERIC TIDES IN THE MIDDLE ATMOSPHERE [MARES ATMOSFERICAS NA MEDIA ATMOSFERA]**
Marden Herbert Silva Souza Mar. 1992 68 p In PORTUGESE
(INPE-5436-PUD/053) Avail: CASI HC A04/MF A01

The atmospheric tides are one of the most regular and conspicuous dynamic phenomena of the middle atmosphere (approximately 15 - 100 km) and dominate the meteorology of the upper mesosphere and low thermosphere (approximately 70 - 110 km). Despite the fact that they have been known since the end of past century, they have not yet been described completely in a global scale. In this work, a brief report of the theoretical and observational study of the solar atmospheric tides in the middle atmosphere, with emphasis on the evolution of the theoretical models and on the description of general aspects of the recent observational results, is presented. Transl. by FLS

**N93-19795#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**USE OF TELEDETECTION IN PHYSIOGRAPHIC COMPARTMENTATION TO OBTAIN MULTIPLE USE GEOTECHNIC ZONING IN COASTAL REGIONS [USO DE TELEDETECCAO NA COMPARTIMENTACAO FISIOGRAFICA PARA A OBTENCAO DE UM ZONEAMENTO GEOTECNICO DE MULTIPLO USO EM REGIOOES LITORANEAS]**
Ricardo Vedovello and Juercio Tavares deMattos Sep. 1991 9 p In PORTUGESE
(INPE-5322-PRE/1720) Avail: CASI HC A02/MF A01

This paper presents the criteria used in physiographic compartmentation of a coastal region in the state of Sao Paulo, Brazil. This compartmentation constituted the first phase of the process of obtaining geotechnic zoning by means of orbital teledetection. For purposes of refining the compartmentation, a procedure is proposed for verifying the limits, similarity, and homogeneity of the landscape, defined through analysis of the textural and structural elements in satellite images. When associated with a study of the alteration landscape covers, physical compartmentation will produce multiple use geotechnic zoning which serves as an aid to planning of coastal regions with heavy tourist activity. Transl. by FLS

**N93-19824#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**VARIATIONAL ITERATIVE METHOD FOR THE CALCULATION OF HEAT FLUX AND MEAN ENERGY BALANCE [METHODE ITERATIVE VARIATIONNELLE POUR LE CALCUL DU FLUX DE CHALEUR ET BILAN MOYEN D'ENERGIE]**
Ruberio Prado Britto Apr. 1991 34 p In PORTUGESE
(INPE-5236-RPQ/648) Avail: CASI HC A03/MF A01

The experimental means which are used for studying forest dynamics are good enough if one admits their trustworthiness; in spite of that, it is very difficult to make the measurements principally because of the interceptor role played by the canopy and by the soil, which complicate the comprehension of these phenomena. The captors were placed on the instrument tower and placed in the soil, up to a depth of 1 m. After having been submitted to an optimization of the differences in the quarters, the values between the 4 levels and 3 quarters are confirmed to be the most appropriate to be taken into account for the iterative variational calculation. In spite of the doubts which can be had and the criticisms which can be made regarding the aerodynamic method, it was this which was used to establish the daily energy level. It seems that the difficulty with the method was tied, in our case, to the great transparency of the forest (50 percent), to its elevated rugosity, and to the prioritary role played by the interception of rays at the surface. Transl. by FLS

**N93-19856#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**MAVALE PROJECT: SENSOR TECHNIQUES APPLIED TO MACROZONING OF THE PARAIBA VALLEY AND LITTORAL NORTH OF THE STATE OF SAO PAULO [PROJETO MAVALE: TECNICAS DE SENSORIAMENTO APLICADAS AO MACROZONEAMENTO DO VALE DO PARAIBA E LITORAL NORTE DO ESTADO DE SAO PAULO]**
Apr. 1991 13 p In PORTUGESE
(INPE-5332-PRE/1731) Avail: CASI HC A03/MF A01

This project was designed with two basic objectives in mind. The first is to support the Consortium for Integrated Development of the Paraiba Valley and the Northern Littoral (CODIVAP) for preparation of regulatory guidelines for use of the regional lands. The second is to place at the disposal of the country's technical/scientific community a regional planning method based on the use of Remote Orbital Sensor data. This project involved studies on the following areas: maps - geological, pedological, geomorphological, ground cover, land use, urban area and urban expansion in the last decade, areas favorable for replenishment and concentration of ground water; compartmentation of the region into sub-basins and study of the relationships of land use to surface water quality; generation of a map indicating the suitability of land for civil engineering and urban expansion projects and projects subject to geological risk; preparation of a map showing suitability for agricultural use of the land; and social/economic/demographic analysis. The region of the study encompasses 40 municipalities and portions of 4 others, in an overall region of 18.111 sq. km. Imagery from MSS/Landsat, TM/Landsat, and HRV/SPOT was interpreted, exploring the multispectral, multitemporal, synoptic characteristics as well as the detail (compatible with spatial resolutions of the sensor systems). As a function of the objectives of the different thematic studies involved in the environmental and physical diagnostics, images were interpreted visually or processed digitally in alternate scales of 1:250,000, 1:100,000, or 1:50,000. These studies were complemented with pre-existing bibliographical and cartographic information, and the final mapping products are presented to the scale of 1:250,000, compatible with decisions at the regional level. Thematic studies relative to the physical/territorial, and social/economical reality were integrated in the search for holistic understanding of the region and its problems relative to land use and occupation. The macrozoning proposal directed at reorganizing human activities in the regional territory was generated from technical discussions of the body of researchers involved in the project and representatives of the municipalities which comprise the region of the study. Transl. by FLS

**N93-19886*#** Georgia Inst. of Tech., Atlanta. School of Electrical Engineering.
**INVESTIGATION OF PASSIVE ATMOSPHERIC SOUNDING USING MILLIMETER AND SUBMILLIMETER WAVELENGTH CHANNELS**
**Semiannual Status Report No. 3, 1 Jan. - 30 Jun. 1992**
Albin J. Gasiewski, D. B. Kunkee, D. M. Jackson, and L. K. Adelberg 30 Jun. 1992 69 p
(Grant NAG5-1490)
(NASA-CR-192098; NAS 1.26:192098) Avail: CASI HC A04/MF A01

Activities within the period from January 1, 1992 through June 30, 1992 by Georgia Tech researchers in millimeter and submillimeter wavelength

tropospheric remote sensing have been centered around the integration and initial data flights of the MIR on board the NASA ER-2. Georgia Tech contributions during this period include completion of the MIR flight software and implementation of a 'quick-view' graphics program for ground based calibration and analysis of the MIR imagery. In the current configuration, the MIR has channels at 90, 150, 183 +/- 1,3,7, and 220 GHz. Provisions for three additional channels at 325 +/-1,3 and 9 GHZ have been made, and a 325-GHz receiver is currently being built by the ZAX Millimeter Wave Corporation for use in the MIR. The combination of the millimeter wave and submillimeter wave channels aboard a single well-calibrated instrument will provide the necessary aircraft radiometric data for radiative transfer and cloud and water vapor retrieval studies. A paper by the PI discussing the potential benefits of passive millimeter and submillimeter wave observations for cloud, water vapor and precipitation measurements has recently been accepted for publication (Gasiewski, 1992), and is included as Appendix A. The MIR instrument is a joint project between NASA/GSFC and Georgia Tech. Other Georgia Tech contributions to the MIR and its related scientific uses have included basic system design studies, performance analyses, and circuit and radiometric load design. Author

**N93-18495#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**ATMOSPHERIC DYNAMICS AND COUPLING**
R. L. Walterscheid, L. R. Lyons, M. N. Ross, and G. Schubert *In its* Aerospace Sponsored Research 1 Dec. 1991 p 117-119 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18496#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**AERONOMY OF AURORAL AND AIRGLOW EMISSIONS**
J. H. Hecht and L. K. Johnson *In its* Aerospace Sponsored Research 1 Dec. 1991 p 119-123 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18498#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**IONOSPHERIC PROCESSES**
F. T. Djuth *In its* Aerospace Sponsored Research 1 Dec. 1991 p 125-129 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18499#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**AURORAL ENERGIZATION AND GEOMAGNETIC DISTURBANCES**
L. R. Lyons, M. Schulz, and J. F. Fennell *In its* Aerospace Sponsored Research 1 Dec. 1991 p 129-132 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18718*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY. Lab. for Atmospheres.
**NUMERICAL EXPERIMENTS ON CONSISTENT HORIZONTAL AND VERTICAL RESOLUTION FOR ATMOSPHERIC MODELS AND OBSERVING SYSTEMS Abstract Only**
Michael S. Fox-Rabinovitz and Richard S. Lindzen (Massachusetts Inst. of Tech., Cambridge.) *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 2 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

**N93-18719*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY. Lab. for Atmospheres.
**DIABATIC DYNAMIC INITIALIZATION Abstract Only**
Michael S. Fox-Rabinovitz and Brian D. Gross *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 2 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

**N93-19416*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.
**THE EFFECT OF TROPOSPHERIC FLUCTUATIONS ON THE ACCURACY OF WATER VAPOR RADIOMETRY**
J. Z. Wilcox *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 33-51 (For primary document see N93-19413 06-32)
(RTOP 310-10-60-86-02)
Avail: CASI HC A03/MF A03

**N93-19555#** EISCAT Scientific Association, Kiruna (Sweden).
**RESEARCH OF THE POLAR MIDDLE AND LOWER ATMOSPHERE WITH AN MST RADAR ON SPITSBERGEN (SVALBARD, ARCTIC) Abstract Only**
Juergen Roettger *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19563#** Grenoble-1 Univ. (France). Centre d'Etude des Phenomenes Aleatoires et Geophysiques.
**EISCAT-MICADO COORDINATED MEASUREMENTS OF MERIDIONAL NEUTRAL WINDS AND TEMPERATURES IN THE F REGION Abstract Only**
C. Lathuillere, G. Thuillier (Centre National de la Recherche Scientifique, Verrieres-Le Buisson, France ), J. Lilensten, D. Hubert (Observatoire de Paris-Meudon, France ), M. Herse (Centre National de la Recherche Scientifique, Verrieres-Le Buisson, France ), and V. Fauliot (Centre National de la Recherche Scientifique, Verrieres-Le Buisson, France ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19568#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).
**NONLINEAR INTERACTIONS ASSOCIATED WITH TID'S IN THE QUIET POLAR F-REGION FROM EISCAT OBSERVATIONS Abstract Only**
Shuying Ma and Kristian Schlegel *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

## 47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

**N93-17858#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**TEMPORAL VARIABILITY OF THE TRADE WIND INVERSION: MEASURED WITH A BOUNDARY LAYER VERTICAL PROFILER M.S. Thesis**
Cecilia M. Grindinger May 1992 106 p
(AD-A258189; AFIT/CI/CIA-92-098) Avail: CASI HC A06/MF A02

This study uses Hawaiian Rainband Project (HaRP) data, from the summer of 1991, to show a boundary layer wind profiler can be used to measure the trade wind inversion. An algorithm has been developed for the profiler that objectively measures the depth of the moist oceanic boundary layer. The Hilo inversion, measured by radiosonde, is highly correlated with the moist oceanic boundary layer measured by the profiler at Paradise Park. The inversion height on windward Hawaii is typically 2253 + or - 514 m. The inversion height varies not only on a daily basis, but on less than an hourly basis. It has a diurnal, as well as a three to four day cycle. There appears to be no consistent relationship between inversion height and precipitation. Currently, this profiler is capable of making high frequency (12 minute) measurements of the inversion base variation, as well as other features. GRA

**N93-17859#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**A DYNAMICAL THEORY FOR HURRICANE SPIRAL BANDS Ph.D. Thesis**
Thomas A. Guinn May 1992 192 p
(AD-A258190; AFIT/CI/CIA-92-020D) Avail: CASI HC A09/MF A02

A dynamical theory is presented for two classes of hurricane spiral

bands - inner and outer. Inner bands, which typically form within 500 km of the vortex center, can result from both potential vorticity (PV) wave breaking and vortex merger. PV wave breaking is found to occur when the PV field is asymmetric. This process ejects relatively high PV air down gradient into regions of relatively low PV air in the form of spiral bands. Vortex merger occurs when a vortex moves sufficiently close to a PV source. This process also produces inner spiral bands. The inner bands modeled in this study were found to project almost entirely onto the rotational modes, thus suggesting they are a slow-manifold phenomenon rather than a gravity wave phenomenon as previously proposed. Outer bands, which typically form at a radius greater than 500 km from the vortex center, are found to occur as a result of the intertropical convergence zone (ITCZ) breakdown. Both types of bands are found to be stabilized by the adverse shear created by the main vortex. All theories are tested through the integration of a limited area, normal mode, spectral model. GRA

**N93-17901#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**RADAR BASED CASE STUDY OF A NORTHEAST COLORADO WINTER STORM M.S. Thesis**
Nicolas S. Powell 1 Jun. 1992 175 p
(AD-A258256; AFIT/CI/CIA-92-099) Avail: CASI HC A08/MF A02

Radar and conventional meteorological data collected during the 19-20 January 1991 winter storm over Northeast Colorado as part of WISP-91 (Winter Icing and Storm Project) were analyzed to describe observations of snow bands and possible band formation mechanisms. A review of the synoptic situation led to classification of this storm as an anticyclonic type of upslope storm. Single and dual-Doppler radar analyses showed well organized mesoscale snow bands oriented west-southwest to east-northeast, parallel to the 800-400 mb thermal wind, formed during upslope conditions several hours after passage of an arctic cold front over the research area. Embedded within the bands were precipitation cores that propagated along the band with the upper level winds and nearly stationary (band relative) trapped mountain waves. The evolution and structure of snowband kinematic properties were studied by analysis of horizontal and vertical velocity profiles and reflectivity distributions using PPI scans and Extended Velocity Azimuth Display (EVAD) techniques. Various mechanisms were examined for their potential role in formation and maintenance of snow bands. These mechanisms included: conditional instability, Conditional Symmetric Instability (CSI), ducted and internal gravity waves, jet streak circulations, seeder-feeder cloud structures, and terrain induced phenomena such as trapped mountain waves, low level barrier jets, and cold air damming. GRA

**N93-17987#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**SAR-RELATED STRESS VARIABILITY IN THE MARINE ATMOSPHERIC BOUNDRY LAYER (MABL) (HIGH RESOLUTION ARI)**
Hampton N. Shier and George S. Young 1992 39 p
(AD-A258317) Avail: CASI HC A03/MF A01

By stressing the sea surface, the marine atmospheric boundary layer (MABL) can alter the sea surface wave field and so can produce discernible signatures on SAR images of the ocean (e.g., Visecky and Stewart 1982). Among the resulting signatures, the quasi-linear and cellular microscale patterns still require adequate explanation. The ubiquitous MABL two- and three-dimensional convective circulations provide promising candidates for the forcing phenomena producing these signatures. These microscale circulations have horizontal wavelengths on the order of one to ten times the boundary layer depth, or approximately one to ten km, and temporal scales on the order of one to ten hours. Thus, they produce stress variations on the spatial and temporal scales of the quasi-linear and cellular SAR signatures. GRA

**N93-18001*#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**LOW CLOUD INVESTIGATIONS FOR PROJECT FIRE: ISLAND STUDIES OF CLOUD PROPERTIES, SURFACE RADIATION, AND BOUNDARY LAYER DYNAMICS. A SIMULATION OF THE REFLECTIVITY OVER A STRATOCUMULUS CLOUD DECK BY THE MONTE CARLO METHOD M.S. Thesis Final Report**
Thomas P. Ackerman and Ruei-Fong Lin 1 Feb. 1993 87 p
(Grant NAG1-652)
(NASA-CR-192083; NAS 1.26:192083) Avail: CASI HC A05/MF A01

The radiation field over a broken stratocumulus cloud deck is simulated by the Monte Carlo method. We conducted four experiments to investigate the main factor for the observed shortwave reflectively over the FIRE flight 2 leg 5, in which reflectivity decreases almost linearly from the cloud center to cloud edge while the cloud top height and the brightness temperature remain almost constant through out the clouds. From our results, the geometry effect, however, did not contribute significantly to what has been observed. We found that the variation of the volume extinction coefficient as a function of its relative position in the cloud affects the reflectivity efficiently. Additional check of the brightness temperature of each experiment also confirms this conclusion. The cloud microphysical data showed some interesting features. We found that the cloud droplet spectrum is nearly log-normal distributed when the clouds were solid. However, whether the shift of cloud droplet spectrum toward the larger end is not certain. The decrease of number density from cloud center to cloud edges seems to have more significant effects on the optical properties. Author

**N93-18010#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**TROPICAL CYCLONE MOTION AND RECURVATURE IN TCM-90 M.S. Thesis**
Michael E. Fitzpatrick 1992 82 p
(AD-A258258; AFIT/CI/CIA-92-108) Avail: CASI HC A05/MF A01

Rawinsonde and satellite data collected during the Tropical Cyclone Motion (TCM90) experiment, which was conducted during the summer of 1990 in the Western North pacific, is used to examine tropical cyclone steering motion and recurvature. TCM-90 composite results are compared with those found in a composite study using twenty-one years (1957-77) of Western North Pacific rawinsonde data during the same August-September period and also for all months during this same 21-year period. Both data sets indicate that the composite deep-layer-mean (850-300 mb) winds 5-7 deg from the cyclone center provide an important component of the steering flow for tropical cyclones. However, despite the rawinsonde data enhancements of the TCM-90 experiment, data limitations prevented an accurate observation of steering flow conditions at individual time periods or for the average of only 5-10 time periods when composited together. GRA

**N93-18012#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**PREDICTING THE MOVEMENT OF CAROLINA COASTAL FRONTS M.S. Thesis**
William C. Tasso 1992 133 p
(AD-A258280; AFIT/CI/CIA-92-097) Avail: CASI HC A07/MF A02

The topic of coastal front movement has been largely neglected especially in the vicinity of the Carolinas. Since the presence and subsequent movement of the front can effect a significant change in a nearby stations' winds, temperature, and precipitation type, the accurate prediction of coastal front movement is essential to local forecast precision. National Meteorological Center (NMC) three-hourly surface charts for the months of November to March were examined for the years 1975-1989. This search netted 51 Carolina coastal front cases which occurred coincident with Appalachian cold air damming and met additional selection criteria. Although all the cases exhibited a frontal passage at Cape Hatteras, North Carolina, it was found that only two-thirds of the fronts actually migrated inland. In addition the events were determined to have a peak frequency in the month of January, and a mean axis of stagnation, for onshore cases, that is approximated by a line from Hampton, Virginia to Myrtle Beach, South Carolina. The use of NMC historical grid point data enabled the construction of climatic, composite, and deviation charts which suggest that offshore events are characterized by damming high pressure centers located farther west and with isobars which are oriented, perpendicular to the coast for a longer duration. GRA

**N93-18043** ESDU International Ltd., London (England).
**COMPUTER PROGRAM FOR WIND SPEEDS AND TURBULENCE PROPERTIES: FLAT OR HILLY SITES IN TERRAIN WITH ROUGHNESS CHANGES**
Dec. 1992 28 p
(ESDU-92032; ISBN-0-85679-838-X) Avail: ESDU

ESDU 92032 introduces a BASIC program, ESDUpac A9232, that applies to neutral atmospheres or strong winds. It is provided on disc for use on PC DOS systems in compiled form with user-friendly prompting for input data. It can be used to calculate at specified heights from a knowledge

of the reference wind speed the hourly-mean wind speed and maximum gust speed, and the turbulence intensity, integral length scales and spectral density of the longitudinal, lateral and vertical components of turbulence. Alternatively it can be used to correct measured wind properties (such as those from a meteorological station) to values for some other specific terrain. The program takes into account topographic effects on wind speed due to the location of the site anywhere on a hill or in a valley, or in proximity to an embankment, or an escarpment or cliff. Variations in terrain roughness upwind and of water surface roughness with wind speed are also accounted for. The input to and output from the program are fully explained, and a worked example illustrates its use. ESDU

**N93-18194#** Clemson Univ., SC. Dept. of Physics.
**RADAR INTERFEROMETER INVESTIGATIONS OF THE HORIZONTAL WINDS, VERTICAL VELOCITIES, VORTICITY, AND DIVERGENCE AROUND FRONTAL ZONES AND IN MESOSCALE WAVES Annual Report, 15 Sep. 1991 - 14 Sep. 1992**
Miguel F. Larsen 14 Sep. 1992 185 p
(Grant AF-AFOSR-0384-91)
(AD-A257969; AFOSR-92-0945TR) Avail: CASI HC A09/MF A02

The goal of the research has been to use the state-of-the-art, phased-array MU radar facility in Kyoto, Japan, to study the perturbation winds and turbulence associated with frontal zones and mesoscale waves. There are four critical parameters in the dynamical studies. They include the following: unbiased estimates of the horizontal winds, unbiased estimates of the vertical velocities, the location and strength of turbulent layers within the scattering volume, and the vorticity and divergence within the flow. Standard beam-swinging Doppler measurements lead to large biases in the vertical velocities and possible biases in the horizontal winds, the location of the scattering layers can only be determined with the uncertainty of the pulse volume, and vorticity measurements are not possible. Research during the first year has focused on the development of techniques for eliminating large biases in vertical velocity measurements that result when standard vertical beam Doppler methods are used, for eliminating biases in horizontal wind measurements that result with Doppler beam swinging techniques due to horizontal gradients in the flow. We have also worked on developing new techniques for measuring the vorticity and divergence in the flow. The MU radar operates at a frequency close to 50 MHz and has a transmitting/receiving antenna array 103 m in diameter. The beam can be steered from pulse to pulse, and the receiving array can easily be divided into sub-arrays for reception. All the system parameters are under software control so that changes can easily be implemented, and different experimental configurations can be tested quickly. GRA

**N93-18338#** Naval Postgraduate School, Monterey, CA.
**DEFINITION OF MEAN ENVIRONMENTAL STEERING FLOW FOR TCM-90 TROPICAL CYCLONES M.S. Thesis**
Richard H. Bohner, Jr. Sep. 1992 90 p
(AD-A257886) Avail: CASI HC A05/MF A01

A definition for the environmental steering flow in the vicinity of the TCM-90 tropical cyclones is sought by low-pass filtering the Naval Operational Global Atmospheric Prediction System deep-layer mean u- and v- velocity and geopotential height fields. One-dimensional and two-dimensional Fourier decompositions in a limited region (120 deg long) and in a global region are compared with six wave number low-pass filters (1-6,19,...,1-21). The measure of goodness of the environmental steering flow interpolated to the storm position was to determine the minimum standard deviations of the propagation vector (defined as difference between storm motion and the steering estimate) for all six storms and the ensemble. The best results were found for either the limited region and global one-dimensional Fourier analyses of the u and v wind fields with a low-pass filter that included only wavenumbers 1-15. The six TCM-90 tropical cyclones were subsequently analyzed using this definition of the steering flow to estimate the propagation vectors and to examine the linear shear and relative vorticity gradients of the environmental flow. Except for early stages of storms in low latitudes, the low-pass filtered analyses provided steering vectors consistent with the changing translation directions. However, the translation speeds tended to exceed the storm motion and lead to more westward propagation vectors than expected. These propagation vectors tended to be almost perpendicular to the absolute vorticity gradient vector. GRA

**N93-18342#** National Climatic Data Center, Asheville, NC. Global Analysis Branch.
**US NAVEY REGIONAL CLIMATIC STUDY OF THE GREENLAND-ICELAND-UNITED KINGDOM GAP AND ASSOCIATED WATERS Final Report**
William A. Bower, Jr., William O. Brown, Ronald G. Baldwin, and Phala L. Franks Feb. 1992 280 p
(AD-A257909; NAVAIR-50-1C-560) Avail: CASI HC A13/MF A03

This climatic study of The Greenland-Iceland-United Kingdom Gap and Associated Waters consists of monthly isopleth charts and/or tables of: (1) clouds; (2) precipitation; (3) visibility; (4) mid and low range ceiling and visibilities; (5) wind-visibility-cloudiness, (6) mean scalar wind speed; (7) wind speed less than 11 knots and greater or equal to 34 knots; (8) wind speed 11-21 knots and 22-33 knots; (9) surface wind roses; (10) air and sea surface temperature; (11) wave height; (12) surface currents; and (13) station climate summaries. GRA

**N93-18360*#** Oregon State Univ., Corvallis. Coll. of Oceanography.
**ANALYSIS OF AVHRR, CZCS AND HISTORICAL IN SITU DATA OFF THE OREGON COAST Final Report**
P. Ted Strub and Dudley B. Chelton 1990 10 p
(Grant NAGw-869)
(NASA-CR-192120; NAS 1.26:192120) Avail: CASI HC A02/MF A01

The original scientific objectives of this grant were to: (1) characterize the seasonal cycles and interannual variability for phytoplankton concentrations and sea surface temperature (SST) in the California Current using satellite data; and (2) to explore the spatial and temporal relationship between these variables and surface wind forcing. An additional methodological objective was to develop statistical methods for forming mean fields, which minimize the effects of random data gaps and errors in the irregularly sampled CZCS (Coastal Zone Color Scanner) and AVHRR (Advanced Very High Resolution Radiometer) satellite data. A final task was to evaluate the level of uncertainty in the wind fields used for the statistical analysis. Funding in the first year included part of the cost of an image processing system to enable this and other projects to process and analyze satellite data. This report consists of summaries of the major projects carried out with all or partial support from this grant. The appendices include a list of papers and professional presentations supported by the grant, as well as reprints of the major papers and reports. Author

**N93-18403#** Massachusetts Univ., Amherst.
**DIAGNOSTIC STUDIES OF CLIMATE VARIABILITY**
R. S. Bradley and H. F. Diaz (National Oceanic and Atmospheric Administration, Boulder, CO.) 1992 12 p
(Contract DE-FG02-89ER-69017)
(DE93-002837; DOE/ER-69017/4) Avail: CASI HC A03/MF A01

This paper reports on the progress on the first year of the diagnostic studies of climate variability project. The objectives were as follows: to initiate studies of long-term climatic variability, using long instrumental data sets, and proxy records; to examine regional changes of temperature and precipitation over the past century in relation to changes at the hemispheric and global scale; and to produce a map-based archive of monthly and seasonal temperature, precipitation and pressure data for display on PCs. Significant progress has been made in all of these areas. This paper summarizes results of the work accomplished. Part A summarizes the work accomplished primarily at the University of Massachusetts. Part B summarizes work primarily conducted at NOAA/ERL. A list of papers published, in press, or in preparation then follows. Appendix 1 is a description of the proposed research in 1992-1993, and a proposed budget. DOE

**N93-18454#** Wisconsin Univ., Madison.
**ARM FOURIER TRANSFORM SPECTROMETER DATA ANALYSIS TOOLS**
W. L. Smith 1992 10 p
(Contract DE-FG02-92ER-61365)
(DE93-004648; DOE/ER-61365/1) Avail: CASI HC A02/MF A01

This is the first year mid-term report. Ground-based meteorological field experiments similar to AERI, are serving as the data base for the development of analysis tools prior to AERI installation at the ARM CART site: SPETRE, STORMFEST, and Pt Sur 92. Objectives are to improve infrared radiative transfer models under clear and cloud conditions, develop a method of inferring effective cloud optical properties from FTIR

observations, model effects of cloud properties on radiative properties for interpreting FTIR observations and developing remote sensing, develop a classification method for spectral radiances for atmospheric radiative transfer studies, and develop algorithms for retrieving temperature and constituent profiles from FTIR. DOE

**N93-18592** World Meteorological Organization, Geneva (Switzerland). World Climate Applications and Services Programme.

**URBAN CLIMATOLOGY IN AFRICA. SPECIAL ISSUE OF THE AFRICAN URBAN QUARTERLY, VOLUME 5, NUMBERS 1 AND 2, FEBRUARY AND MAY, 1990**

Yinka R. Adebayo, ed., Rose A. Obudho, ed. (Nairobi Univ., Kenya ), Michael Coquery, ed., Salah El-Shakhs, ed., Alan Frishman, ed., J. B. Ojwang, ed., Harry W. Richardson, ed., Paul Syagga, ed., and Mulatu Wubneth, ed. Aug. 1992 166 p

(WCASP-19; WMO/TD-509) Copyright Avail: CASI MF A08; print copy available at WMO, Geneva, Switzerland

A special issue of the African Urban Quarterly called Urban Climatology in Africa is provided. Papers on the following topics are included: African settlements, climatological information for architects and planners, atmospheric pollution, urban hydrology, African urban environments, atmospheric circulation, urban climate, urban design, and building design. Commentaries are also included. L.R.R.

**N93-18631#** Cologne Univ. (Germany). Mathematisch-Naturwissenschaftlichen Fakultaet.

**EVALUATION OF THE VERTICAL DISTRIBUTION OF THE ICE CONTENT IN CIRRUS CLOUDS FROM COMBINED MEASUREMENTS OF LIDAR AND INFRARED RADIOMETERS Ph.D. Thesis [BESTIMMUNG DER VERTIKALEN VERTEILUNG DES EISGEHALTES IN CIRRUSWOLKEN AUS KOMBINIERTEN LIDAR UND INFRAROT-RADIOMETER MESSUNGEN]**

Annegret Gratzki 1991 104 p In GERMAN

(ETN-93-92740) Avail: CASI HC A06/MF A02

A procedure which derives the vertical distribution of the ice water content in cirrus clouds from combined measurements of lidar backscattered energy and thermal emission is presented. The procedure was tested with measurements of the airborne lidar ALEX F1 and of an infrared radiometer (8 to 14 micrometer). The observations were obtained during the first ICE (International Cirrus Experiments) field phase in Autumn 1987. In a case study the ice water content of a stratiform cirrus field was calculated. The cloud ranges from approximately 7 to 10.5 km at temperatures between -30C and -55C. The ice water content in the stratiform cirrus field showed values up to 30 mg/cu m. Individual cells in the cloud field, with horizontal extensions of several kilometers, reach values up to 100 mg/cu m. The comparison with in situ measurements shows partial agreement in horizontal averages of the ice water content at different heights in the cloud. There is a good qualititative agreement in the horizontal distribution of the ice water content. In an error analysis, the dominant error sources are determined. They are the standard deviation of the effective ice particle radius, the error in determining the emissivity and the uncertainty of the multiple scattering factor. ESA

**N93-18849*#** Kansas Univ. Center for Research, Inc., Lawrence. Radar Systems and Remote Sensing Lab.

**RAWS 1992 PROGRESS REPORT**

Michael A. Stuart Oct. 1992 10 p

(Grant NAG8-893)

(NASA-CR-191382; NAS 1.26:191382; RSL-TR-9550-1) Avail: CASI HC A02/MF A01

The purpose of the Radar Wind Sounder (RAWS) instrument is to measure winds aloft in clouds while providing additional capabilities as an ocean surface-wind and rainfall sensor. The concept of RAWS stems from the Laser Atmospheric Wind Sounder (LAWS) planned to monitor winds via Doppler shifts of lidar return from aerosols in a cloud-free environment. If, however, dense clouds are present, LAWS will be unable to measure the winds below the cloud tops. Thus an instrument that can penetrate clouds is necessary and is the basis for RAWS. The primary tasks related to the RAWS study are to determine: (1) scattering and attenuation models; (2) required radar sensitivity; (3) optical frequencies; (4) needed antenna size; (5) suitable scan pattern; (6) removal of the ambiguity imposed by range and Doppler-frequency sizes; (7) spectrum measurements; (8) system configuration; (9) performance as a rain sensor; and (10) performance as an ocean-surface wind sensor. Author

**N93-19020#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**ANALYSIS OF WHOLE-SKY IMAGER DATA TO DETERMINE THE VALIDITY OF PCFLOS MODELS M.S. Thesis**

Richard W. Boltz and George R. Kather Dec. 1992 272 p

(AD-A259042; AFIT/GSO/ENS/92D-04) Avail: CASI HC A12/MF A03

Models used to predict the probability of a cloud-free line-of-sight (PCFLOS) from the ground to space have existed since the 1960s. Unfortunately, an adequate data set has not been available to check the validity of these models until the deployment of the Whole-Sky Imager (WSI) system in 1989. Now that a three-year database has been collected from the WSI system, it is possible to validate, or refute, the existing models. The most generally accepted models are investigated. Specifically, three questions are investigated: (1) Is the Lund and Shank-lin PCFLOS model assumption of azimuthal independence valid; (2) Does the Lund and Shanklin sub-sampling of data via the use of a template adequately correlate to both the full image and the grid image; and (3) Do the Lund and Shanklin and SRI model estimates correlate to the WSI observations. A methodology which employs time series analysis techniques to evaluate and ultimately corroborate the assumption of azimuthal independence is developed. GRA

**N93-19370#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**REMOTE SENSING OF TURBULENCE AND TRANSVERSE ATMOSPHERIC WIND PROFILES USING OPTICAL REFERENCE SOURCES M.S. Thesis**

Steven C. Koeffler Dec. 1992 116 p

(AD-A258855; AFIT/GE/ENG/92D-22) Avail: CASI HC A06/MF A02

A remote sensing technique for measuring the atmospheric structure constant and the transverse atmospheric wind velocity as a function of altitude is examined by performing temporal and spatial correlations of band pass filtered wave front slope sensor measurements. Two point sources are used to illuminate two pairs-of co-located wave front slope sensors. The sources and sensors are arranged to give rise to crossed optical paths. For each pair of wave front slope sensors, the output of the larger sensor is subtracted from the output of the smaller sensor. This band pass filters the smaller sensor's output. The filtered outputs are then correlated. The spatial correlation is related to the structure constant by an integral containing a path weighting function. The path weighting function is sharply peaked at the intersection altitude and decays rapidly to zero. The temporal correlation is related to the wind velocity through an integral containing a wind path weighting function which is sharply peaked at the intersection altitude and decays rapidly to zero. The vertical resolution of each path weighting function is calculated. Also, signal-to-noise ratios are calculated using generally accepted models for the structure constant and atmospheric wind profiles. GRA

**N93-19481#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**FOUR-DIMENSIONAL DATA ASSIMILATION OF GALE DATA USING A MULTIVARIATE ANALYSIS SCHEME AND A MESOSCALE MODEL WITH DIABATIC INITIALIZATION Ph.D. Thesis**

Dewey E. Harms 1992 239 p

(AD-A258549; AFIT/CI/CIA-92-029D) Avail: CASI HC A11/MF A03

A method of assimilating 3-hourly sounding data is developed and successfully tested in this study. First, the successive corrections scheme of Bratseth (1986), which converges to optimum interpolation, is applied for the numerical analysis of data collected during the Genesis of Atlantic Lows Experiment (GALE). Univariate analyses of the mass and wind field are produced. The coupling of the mass and wind field is achieved by further iterations of the geopotential utilizing improving estimates of the geostrophic wind to extrapolate the geopotential to the grid points. The univariate wind analysis is then corrected for the new geostrophic wind. Next, diabatic forcing is incorporated into a vertical model initialization scheme to provide more realistic initial conditions and to shorten the spinup time of the Naval Research Laboratory/North Carolina State University (NRL/NCSU) mesoscale model. Finally, the multivariate, successive

correction analysis scheme and the diabatic initialization procedure are combined with the NRL/NCSU model to form an intermittent data-assimilation system. GRA

**N93-19638#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**ANALYSIS OF RELATIONAL CONCEPTS FOR THE IMPLEMENTATION OF SYSTEMS FOR THREE-DIMENSIONAL VISUALIZATION OF METEOROLOGICAL DATA [ANALISE DE CONCEITOS RELACIONADOS A IMPLEMENTACAO DE SISTEMAS DE VISUALIZACAO TRIDIMENSIONAL DE DADOS METEOROLOGICOS]**
Andre Luiz Battaiola 1992 135 p In PORTUGESE
(INPE-5435-TAE/016) Avail: CASI HC A07/MF A02

In light of recent increases in computer processing power, weather forecasting is becoming a realistic endeavor. Normally, meteorologists work with large data sets. Hence, the graphical representation of these data associated with satellite or radar images are important resources to study the climate behavior. In this regard, systems of meteorological data visualization have proved to be important tools for the meteorologists. The author, based on the knowledge obtained working in INPE's project to implement the meteorological data visualization system MicroMAGICS and in research performed at the Space Science and Engineering Center, where he studied techniques to generate graphics in three dimensions, analyzes the main characteristics of these systems and suggests some methods to develop them. He also describes an algorithm to generate three dimensional surfaces that can be used to visualize many physical fields. Specifically, fields related to the climate. The development and implementation of this algorithm is the kernel of this work. Author

**N93-19887*#** Nevada Univ. System, Reno. Desert Research Inst.
**AN EXPERIMENTAL STUDY OF GROWTH AND PHASE CHANGE OF POLAR STRATOSPHERIC CLOUD PARTICLES Semiannual Status Report, 1 Jul. - 31 Dec. 1991**
John Hallett and Edward Teets Mar. 1992 17 p
(Grant NAGw-2572)
(NASA-CR-192369; NAS 1.26:192369) Avail: CASI HC A03/MF A01

This report describes the progress made on understanding phase changes related to solutions which may comprise Polar Stratospheric Clouds. In particular, it is concerned with techniques for investigating specific classes of metastability and phase change which may be important not only in Polar Stratospheric Clouds but in all atmospheric aerosols in general. While the lower level atmospheric aerosol consists of mixtures of (NH4)(SO4)2, NH4HSO4, NaCl among others, there is evidence that aerosol at PSC levels is composed of acid aerosol, either injected from volcanic events (such as Pinatubo) or having diffused upward from the lower atmosphere. In particular, sulfuric acid and nitric acid are known to occur at PSC levels, and are suspected of catalyzing ozone destruction reactions by adsorption on surfaces of crystallized particles. The present study has centered on two approaches: (1) the extent of supercooling (with respect to ice) and supersaturation (with respect to hydrate) and the nature of crystal growth in acid solutions of specific molality; and (2) the nature of growth from the vapor of HNO3 - H2O crystals both on a substrate and on a pre-existing aerosol. Author

**N93-19898*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**WILDFIRE AND MAMS DATA FROM STORMFEST**
Gary J. Jedlovec and G. S. Carlson (Universities Space Research Association, Huntsville, AL.) Jan. 1993 31 p
(NASA-TM-108393; NAS 1.15:108393) Avail: CASI HC A03/MF A01

Early in 1992, NASA participated in an inter-agency field program called STORMFEST. The STORM-Fronts Experiment Systems Test (STORMFEST) was designed to test various systems critical to the success of STORM 1 in a very focused experiment. The field effort focused on winter storms in order to investigate the structure and evolution of fronts and associated mesoscale phenomena in the central United States. This document describes the data collected from two instruments onboard a NASA ER2 aircraft which was deployed out of Ellington Field in Houston, Texas from February 13 through March 15, 1992, in support of this experiment. The two instruments were the Wildfire (a.k.a. the moderate resolution imaging spectrometer-nadir (MODIS-N) Airborne Simulation (MAS)) and the Multispectral Atmospheric Mapping Sensor (MAMS). Author

**N93-18720*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.
**A COMPARISON OF AIRBORNE AND GROUND-BASED RADAR OBSERVATIONS WITH RAIN GAGES DURING THE CaPE EXPERIMENT**
Makoto Satake, David A. Short, and Toshio Iguchi *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 3 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

**N93-19403*#** Wisconsin Univ., Green Bay. Dept. of Physics.
**DETERMINATION AND REPRESENTATION OF ELECTRIC CHARGE DISTRIBUTIONS ASSOCIATED WITH ADVERSE WEATHER CONDITIONS**
John T. Rompala *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 391-420 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

**N93-19411*#** University of Western Carolina, Cullowhee, NC. Mathematics and Computer Science Dept.
**HURRICANE RISK ASSESSMENT TO ROLLBACK OR RIDE OUT A COST VERSUS LOSS DECISION MAKING APPROACH**
Richard A. Wohlman *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 593-632 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A05

## 48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

**N93-17984#** Office of Naval Research, Arlington, VA.
**THE VOLTAMMETRIC DETERMINATION OF TRACE METAL CONCENTRATIONS AND ORGANIC COMPLEXATION IN SEAWATER Final Report**
Kenneth W. Bruland 20 Jul. 1992 3 p
(Contract N00014-89-J-1716)
(AD-A257565) Avail: CASI HC A01/MF A01

Biological processes can strongly influence the oceanic chemistries of trace metals and, in turn, trace metals can influence plankton production and community structure. Our knowledge of the oceanic concentrations, distributions, and cycles of trace metals have advanced significantly (see Bruland 1983; Whitfield and Turner 1987). We now know the bioactive trace metals exist at nanomolar (10-9 M) to picomolar (10-12 M) concentrations in oceanic waters. In addition, marine chemists have recently advanced their ability to characterize the chemical speciation of these bioactive trace metals in the sea: we can now determine their free ion concentrations and the extent to which certain trace metals interact with organic and inorganic ligands naturally present in oceanic surface waters. GRA

**N93-18009#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**BACKSCATTER OF BOTTOM REFLECTED LIGHT INTO THE DOWNWELLING LIGHT STREAM Final Report**
L. Estep May 1992 4 p
(AD-A258165; NOARL-PR92-043-352) Avail: CASI HC A01/MF A01

Various remote sensing equations dealing with ocean color models include the bottom reflectance as a significant variable. Bottom spectral reflectance quantifies the effect the optical characteristics of the bottom sediments have on the upwelling light field. In optically shallow waters which possess a large bottom component in the upwelling light field, light reflected from the bottom can be backscattered into the uplooking irradiance stream and influence the spectral content of the measured downwelling signal. The extent to which this occurs is important to quantify simply because the measurement of water reflectances are biased by this process. Thus, any computations which are based upon these measurements are to some degree suspect. The objective of this work is to model the

contamination of the downwelling stream due to the backscatter of the bottom light field. Then the model will be used to determine the extent of 'contamination' using collected field data. GRA

**N93-18124#** Scripps Institution of Oceanography, La Jolla, CA.
**TOPOGRAPHY-INDUCED VARIATION IN BENTHIC BOUNDARY LAYER PARTICLE DYNAMICS AND FAUNA Final Technical Report**
Lisa A. Levin 1992 7 p
(Contract N00014-89-J-3072)
(AD-A258230) Avail: CASI HC A02/MF A01

The long term objective of this research was to identify the physical and biological mechanisms that regulate the structure of infaunal communities on Pacific seamounts. Of particular interest were the interrelationships of hydrodynamic regime, organic input, sediment properties, oxygen availability, and their influence on infaunal communities inhabiting seamounts. Studies involved comparisons of sediments and infauna in naturally-varying and experimentally-manipulated settings on Volcano 7 off Mexico and the summit plain of Fieberling Guyot. Seamounts serve as excellent models for evaluating the response of benthic assemblages to physical processes in the open ocean. Author (GRA)

**N93-18254#** Washington Univ., Seattle.
**MULTI-DISCIPLINE ARCTIC OCEANOGRAPHY AND ACOUSTICS PROGRAM: THE GEODESIC UNDERICE TRAMWAY SYSTEM (GUTS) Final Report, FY 1991 - 1992**
Terry E. Ewart, LeRoy O. Olson, and Eric L. Thorsos 1992 3 p
(Contract N00014-90-J-1221)
(AD-A258323) Avail: CASI HC A01/MF A01

The Multi-Discipline Group was engaged in a research program for FY91-92 in Arctic oceanography and acoustic scattering. The purpose of this project was to develop and operate a system capable of accurately mapping the topography and elastic constants of sea ice with spatial precision to a fraction of a meter (required to characterize the Bragg wavenumber structure for acoustic backscatter studies). The system would be capable of conducting detailed oceanographic studies under the ice canopy, where ice topography and heat and salt budgets are difficult to study over wide areas, and in shallow bay areas where near-surface processes are important. The main research objective was to complete the dynamic analysis, mechanical design, construction and testing of the Geodesic Underice Tramway System (GUTS). A secondary objective was to work with research scientists in oceanography, ice mechanics and acoustics on the development of instrument suites to be carried by the apparatus. GRA

**N93-18255#** Massachusetts Inst. of Tech., Cambridge. Dept. of Earth Atmospheric and Planetary Sciences.
**MODELLING STUDIES IN SUPPORT OF OPEN-OCEAN CONVECTION FIELD PROGRAMS Report, 1991 - 1992**
John C. Marshall 1992 4 p
(AD-A258324) Avail: CASI HC A01/MF A01

We have begun an inquiry into the process of open-ocean deep convection guided by the field observations collected in the western Mediterranean during the past winter. Our goals are to understand the role of planetary rotation in the sinking and spreading of cold water and test our understanding against field observations and laboratory models. Objectives were to understand and parameterize the convective scale in general circulation models and to provide a context in which to design future observing programs for open-ocean deep convection. GRA

**N93-18279#** Naval Postgraduate School, Monterey, CA.
**CONDITIONING INSTABILITIES OF THE GREENLAND SEA M.S. Thesis**
James M. Olson Sep. 1992 57 p
(AD-A257547) Avail: CASI HC A04/MF A01

This is an examination of the open ocean deep water formation process of the Greenland Sea and how it is effected by the depth dependent thermal expansion coefficient. It is hypothesized that free convection associated with parcel instability is possible because of the increase in the thermal expansion coefficient with pressure in conjunction with requisite ambient temperature and salinity profiles. Based on the depth dependence of the thermal expansion coefficient, a neutral profile model for parcel instability was formulated and the effects on mixed layer dynamics were investigated. In situ profiles for the wintertime Greenland Sea were examined for potential parcel instabilities. It was shown that only small surface salinity increases associated with freezing could lead to deep penetrative convection. Finally, an analysis was performed for regions of low stability using climatology from the Levitus data set to determine regions most likely for deep convection. GRA

**N93-18394#** Naval Postgraduate School, Monterey, CA.
**DEVELOPMENT AND CALIBRATION OF TWO AND FOUR WIRE WATER SURFACE WAVE HEIGHT MEASUREMENT SYSTEMS M.S. Thesis**
Robert K. Yarber Dec. 1992 133 p
(AD-A257900) Avail: CASI HC A07/MF A02

Capacitance and conductance measurements using two and four wire techniques were developed and statically and dynamically calibrated in this thesis. The voltage sensitivities range from 7.3 to 8.1 +/- 0.1 mV/cm for the two wire capacitance system static calibrations. This is +/- 5.2 percent of the limiting theoretical value. The voltage sensitivities range from 0.3 to 0.4 +/- 0.1 V/cm for the four wire conductance system static calibrations. Dynamic calibrations were only completed for the conductance system. The dynamic calibration results were weakly frequency dependent with a w(exp -0.15) decay in a limited, 2-4 Hz range. Wind power spectrum measurements were taken in the existing Upper Ocean Simulations Facility at the Naval Postgraduate School. There was excellent agreement in the spectra with both techniques. Driven gravity wave frequency down-shifting and wind energy dumping was observed in the combined gravity wave and wind-wave measurements. The power spectra peaked near two Hertz and decayed at 50 to 70 dB per decade, or as w(exp -5) to w(exp -7) for both systems. GRA

**N93-18430#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**MAPPING OF SEA BOTTOM TOPOGRAPHY WITH SPACEBORNE SAR**
S. Boer (Delft Hydraulics Lab., Netherlands ) and J. Vogelzang (Rijkswaterstaat, Delft, Netherlands ) Apr. 1992 77 p
(BCRS Proj. OP-1.28)
(BCRS-91-14; ISBN-90-5411-043-0; ETN-92-92838) Avail: CASI HC A05/MF A01

The sea bottom topography in a test area 30 km off the coast of the Netherlands will be studied with the C band Synthetic Aperture Radar (SAR) of the ERS-1. The test area has a simple, quasi-one-dimensional bottom topography consisting of sand waves. Preparations made for the interpretation of the ERS-1 SAR images are described. The aim was to construct a three dimensional model of the test area. The first step to obtain information on surface currents in the test area is described: the computation of the depth averaged tidal currents. A description of the computations carried out for different tidal conditions, ranging from spring tide to neap tide, is given. The computational results of the most refined model are stored in a well defined data base which is described. Other preparations made for the interpretation of the ERS-1 images are discussed: the update of the digitized bathymetric map of the test area; and the update of the modeling software. ESA

**N93-18432#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**FEASIBILITY OF AIRBORNE LASERBATHYMETRY WITH RESPECT TO TURBIDITY IN DUTCH COASTAL WATERS**
H. C. Peters (Rijkswaterstaat, Delft, Netherlands ), J. W. Hofstraat (Rijkswaterstaat, Delft, Netherlands ), J. Vogelzang (Rijkswaterstaat, Delft, Netherlands ), G. Marees (Nederlands Inst. voor Onderzoek der Zee, Texel.), M. R. Wernand (Nederlands Inst. voor Onderzoek der Zee, Texel.), and A. H. J. M. Pellemans (Rijkswaterstaat, Delft, Netherlands ) Jun. 1992 38 p
(BCRS Proj. TO-1.27)
(BCRS-91-19; ISBN-90-5411-051-1; ETN-92-92841) Avail: CASI HC A03/MF A01

The application of airbone laser bathymetry, an efficient and flexible modern remote sensing depth measuring technique, to Dutch coastal waters, is assessed. The advantages of this technique are outlined, and the limiting factors are considered. It is concluded that the actual penetration capability of an airborne laser bathymeter is critically dependent on water clarity, which is relatively low in the turbid Dutch coastal waters. Several commonly used turbidity parameters are analyzed and the penetration depth of the Larsen 500 lidar system as a function of these turbidity parameters was taken as a representative example of the state of the art technology.

Several independent turbidity data sets containing over 3000 optical measurements were used to assess the applicability of laser bathymetry in Dutch coastal waters. From the statistical analysis of the turbidity measurements it is concluded that the penetration probability is certainly no more than about 10 percent and is probably only a few percent. It is evident therefore that laser bathymetry is not applicable in Dutch coastal waters with the present technology. ESA

**N93-18525*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**BOTSWANA WATER AND SURFACE ENERGY BALANCE RESEARCH PROGRAM. PART 2: LARGE SCALE MOISTURE AND PASSIVE MICROWAVES**

A. A. vandeGriend (Vrije Univ., Amsterdam, Netherlands ), M. Owe, and A. T. C. Chang Feb. 1992 55 p Sponsored by Vrije Univ. and Food and Agriculture Organization of the United Nations Prepared in cooperation with Beleidscommissie Remote Sensing

(BCRS Proj. AO-4.4)

(NASA-TM-108608; NAS 1.15:108608; BCRS-91-38B-Pt-2;

ISBN-90-5411-027-9; ETN-92-92843) Avail: CASI HC A04/MF A01

The Botswana water and surface energy balance research program was developed to study and evaluate the integrated use of multispectral satellite remote sensing for monitoring the hydrological status of the Earth's surface. The research program consisted of two major, mutually related components: a surface energy balance modeling component, built around an extensive field campaign; and a passive microwave research component which consisted of a retrospective study of large scale moisture conditions and Nimbus scanning multichannel microwave radiometer microwave signatures. The integrated approach of both components are explained in general and activities performed within the passive microwave research component are summarized. The microwave theory is discussed taking into account: soil dielectric constant, emissivity, soil roughness effects, vegetation effects, optical depth, single scattering albedo, and wavelength effects. The study site is described. The soil moisture data and its processing are considered. The relation between observed large scale soil moisture and normalized brightness temperatures is discussed. Vegetation characteristics and inverse modeling of soil emissivity is considered. ESA

**N93-18982#** Moss Landing Marine Labs., CA.

**UPPER OCEAN MIXING: THE USE OF ALGAL PIGMENTS AS BIOLOGICAL TRACERS FOR TURBULENT DIFFUSION Final Report**

Nicholas Welschmeyer 23 Sep. 1992 4 p

(Contract N00014-87-K-0536)

(AD-A258803) Avail: CASI HC A01/MF A01

The goal of the proposed research was to develop an in situ method for determining upper-ocean mixing rates using algal pigments as natural biological tracers. The work focused specifically on xanthophyll-cycling, a well known series of reversible, light-sensitive pigment transformations that occur in all higher land plants and many marine phytoplankton species. Laboratory work was initiated to define the rate constants for xanthophyll-cycling in microalgal cultures, and to develop a quantitative understanding of the influence of light intensity on the xanthophyll-cycling process. Field work was completed which verified that xanthophyll-cycling processes measured in natural phytoplankton populations indeed reproduced our laboratory observations. A Monte-Carlo computer model was developed in order to study the influence of xanthophyll-cycling on algal pigmentation under known conditions of simulated mixing. The collective results from physiological experimentation and simulation modeling were used to develop a field method for calculating ocean mixing rates (Welschmeyer and Hoepffner, 1991; Welschmeyer 1991). The work has now identified previously unrecognized relationships between xanthophyll- cycling and cellular fluorescence, which are of potential importance in exploiting single-cell characteristics as novel tracers of ocean mixing. This new work is continuing in our laboratory. GRA

**N93-19382** California Univ., San Diego.

**APPLICATIONS OF MARINE GRAVIMETRY TO MID-OCEANIC SPREADING CENTERS AND VOLCANOS Ph.D. Thesis**

James Mark Stevenson 1992 212 p

Avail: Univ. Microfilms Order No. DA9235943

Measurements of the Earth's gravity field on the seafloor and sea surface at mid-oceanic spreading centers are used to obtain mathematical models of density variations in the oceanic crust that may be related to thermal processes that drive seafloor spreading and plate tectonics. Gravimetrically-determined average density values for the shallow oceanic crust at several spreading centers are also obtained. The execution and results of four specific experiments in the Pacific Ocean are discussed. Two of the experiments were conducted on spreading centers where outside evidence indicates that there has been recent volcanically-driven tectonic activity (the East Pacific Rise at 9 deg 48'N and the Juan de Fuca Ridge at 45 deg 03'N). The other two experiments were conducted at volcanos that have erupted on the crest of mid-oceanic ridges, one on a active spreading center (Axial Volcano on the Juan de Fuca Ridge) and one on an extinct spreading ridge (Guadalupe Island on the Guadalupe Fossil Spreading Center). Dissert. Abstr.

## 51 LIFE SCIENCES (GENERAL)

**N93-18351*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**REGENERABLE BIOCIDE DELIVERY UNIT Patent**

Richard L. Sauer, inventor (to NASA) (Umpqua Research Co., Myrtle Creek, OR.), Gerald V. Colombo, inventor (to NASA), and Clifford D. Jolly, inventor (to NASA) (Umpqua Research Co., Myrtle Creek, OR.) 5 Jan. 1993 7 p Filed 18 Mar. 1991 Supersedes N91-25570 (29 - 17, p 2817)

(NASA-Case-MSC-21763-1-SB; US-Patent-5,176,836;

US-Patent-Appl-SN-671603; US-Patent-Class-210-670;

US-Patent-Class-210-739; US-Patent-Class-210-753;

US-Patent-Class-210-764; US-Patent-Class-210-96.1;

US-Patent-Class-210-140; US-Patent-Class-210-190) Avail: US Patent and Trademark Office

A method and apparatus are disclosed for maintaining continuous, long-term microbial control in the water supply for potable, hygiene, and experimental water for space activities, as well as treatment of water supplies on Earth. The water purification is accomplished by introduction of molecular iodine into the water supply to impart a desired iodine residual. The water is passed through an iodinated anion exchange resin bed. The iodine is bound as I-(sub n) at the anion exchange sites and releases I(sub 2) into the water stream flowing through the bed. The concentration of I(sub 2) in the flowing water gradually decreases and, in the prior art, the ion-exchange bed has had to be replaced. In a preferred embodiment, a bed of iodine crystals is provided with connections for flowing water therethrough to produce a concentrated (substantially saturated) aqueous iodine solution which is passed through the iodinated resin bed to recharge the bed with bound iodine. The bed of iodine crystals is connected in parallel with the iodinated resin bed and is activated periodically (e.g., by timer, by measured flow of water, or by iodine residual level) to recharge the bed. Novelty resides in the capability of inexpensively and repeatedly regenerating the ion-exchange bed in situ.

Official Gazette of the U.S. Patent and Trademark Office

**N93-18545*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**EXOBIOLOGY IN SOLAR SYSTEM EXPLORATION**

Glenn C. Carle, ed., Deborah E. Schwartz, ed., and Judith L. Huntington, ed. Aug. 1992 300 p Symposium held in Sunnyvale, CA, Aug. 1988; sponsored by the Exobiology Program of NASA's Division of Life Sciences Original contains color illustrations

(NASA-SP-512; NAS 1.21:512) Avail: CASI HC A13/MF A03; 46 functional color pages

A symposium, 'Exobiology in Solar System Exploration,' was held on 24-26 Aug. 1988. The symposium provided an in-depth investigation of the role of Exobiology in solar system exploration. It is expected that the symposium will provide direction for future participation of the Exobiology community in solar system exploration and alert the Planetary community to the continued importance of an Exobiology Flight Program. Although the focus of the symposium was primarily on Exobiology in solar system exploration missions, several ground based and Earth-orbital projects such as the Search for Extraterrestrial Intelligence, Gas Grain Facility, and Cosmic Dust Collection Facility represent upcoming research opportunities planned

to accommodate the goals and objectives of the Exobiology community as well. This report contains papers for all but one of the presentations given at the symposium. For individual titles, see N93-18546 through N93-18562.

**N93-18546*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**OVERVIEW: EXOBIOLOGY IN SOLAR SYSTEM EXPLORATION**

Glenn C. Carle and Deborah E. Schwartz *In its* Exobiology in Solar System Exploration Aug. 1992 p 3-18 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

In Aug. 1988, the NASA Ames Research Center held a three-day symposium in Sunnyvale, California, to discuss the subject of exobiology in the context of exploration of the solar system. Leading authorities in exobiology presented invited papers and assisted in setting future goals. The goals they set were as follows: (1) review relevant knowledge learned from planetary exploration programs; (2) detail some of the information that is yet to be obtained; (3) describe future missions and how exobiologists, as well as other scientists, can participate; and (4) recommend specific ways exobiology questions can be addressed on future exploration missions. These goals are in agreement with those of the Solar System Exploration Committee (SSEC) of the NASA Advisory Council. Formed in 1980 to respond to the planetary exploration strategies set forth by the Space Science Board of the National Academy of Sciences' Committee on Planetary and Lunar Exploration (COMPLEX), the SSEC's main function is to review the entire planetary program. The committee formulated a long-term plan (within a constrained budget) that would ensure a vital, exciting, and scientifically valuable effort through the turn of the century. The SSEC's goals include the following: determining the origin, evolution, and present state of the solar system; understanding Earth through comparative planetology studies; and revealing the relationship between the chemical and physical evolution of the solar system and the appearance of life. The SSEC's goals are consistent with the over-arching goal of NASA's Exobiology Program, which provides the critical framework and support for basic research. The research is divided into the following four elements: (1) cosmic evolution of the biogenic compounds; (2) prebiotic evolution; (3) origin and early evolution of life; and (4) evolution of advanced life.

Author

**N93-18547*#** Santa Clara Univ., CA. Dept. of Biology.

**THE SOLAR SYSTEM: IMPORTANCE OF RESEARCH TO THE BIOLOGICAL SCIENCES**

Harold P. Klein *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 19-28 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A02/MF A03; 46 functional color pages

An attempt is made to describe the scope of scientific areas that comprise the current field of exobiology in the United States. From investigations of astrophysical phenomena that deal with the birth of stars and planetary systems to questions of molecular biology involving phylogenetic relationships among organisms, from attempts to simulate the synthesis of biological precursor molecules in the chemistry laboratory to making measurements of the organic constituents of Titan's atmosphere, these researches all converge toward a common objective--answering the question of how life came about in the universe. Author

**N93-18548*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**THE MOON: BIOGENIC ELEMENTS**

Everett K. Gibson, Jr. and Sherwood Chang (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 29-44 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

The specific objectives of the organic chemical exploration of the Moon involve the search for molecules of possible biological or prebiological origin. Detailed knowledge of the amount, distribution, and exact structure of organic compounds present on the Moon is extremely important to our understanding of the origin and history of the Moon and to its relationship to the history of the Earth and solar system. Specifically, such knowledge is essential for determining whether life on the Moon exists, ever did exist, or could develop. In the absence of life or organic matter, it is still essential to determine the abundance, distribution, and origin of the biogenic elements (e.g., H, C, O, N, S, P) in order to understand how the planetary environment may have influenced the course of chemical evolution. The history and scope of this effort is presented. Author

**N93-18549*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**VENUS: A SEARCH FOR CLUES TO EARLY BIOLOGICAL POSSIBILITIES**

Larry Colin and James F. Kasting (Pennsylvania State Univ., University Park.) *In its* Exobiology in Solar System Exploration Aug. 1992 p 45-66 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

The extensive evidence that there is no extant life on Venus is summarized. The current atmospheric environment, which is far too hostile by terrestrial standards to support life, is described. However, exobiologists are interested in the possibility of extinct life on Venus. The early history of Venus is discussed in terms of its ability to sustain life that may now be extinct. Author

**N93-18550*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**MARS: A REASSESSMENT OF ITS INTEREST TO BIOLOGY**

Christopher P. McKay *In its* Exobiology in Solar System Exploration Aug. 1992 p 67-82 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

Of all the planets in the solar system, Mars is certainly the one that has inspired the most speculation concerning extraterrestrial life. Observers had long ago noticed that Mars exhibits changes in its polar caps and alterations in its surface coloration that parallel seasonal changes on Earth. The fascination with Mars and the possibility of life on Mars continued into the spacecraft era and was directly expressed in the Viking Missions. These highly successful missions had the search for life on Mars as one of their principal goals. A review of Viking Missions experiments is presented. Results of these investigations are summarized. While the Viking Missions returned a negative answer to the question of life on Mars, they also showed that many years ago Mars was a very different place and enjoyed conditions that may have been conducive to the origin of life - life that may have long since become extinct. Evidence for the existence of water on Mars in the past is presented. Techniques used to study early life on Earth, which may also be used for similar studies on Mars, are described.

L.R.R.

**N93-18551*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**GIANT PLANETS: CLUES ON CURRENT AND PAST ORGANIC CHEMISTRY IN THE OUTER SOLAR SYSTEM**

James B. Pollack and Sushil K. Atreya (Michigan Univ., Ann Arbor.) *In its* Exobiology in Solar System Exploration Aug. 1992 p 83-102 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

The giant planets of the outer solar system - Jupiter, Saturn, Uranus, and Neptune - were formed in the same flattened disk of gas and dust, the solar nebula, as the terrestrial planets were. Yet, the giant planets differ in some very fundamental ways from the terrestrial planets. Despite enormous differences, the giant planets are relevant to exobiology in general and the origin of life on the Earth in particular. The giant planets are described as they are today. Their basic properties and the chemistry occurring in their atmospheres is discussed. Theories of their origin are explored and aspects of these theories that may have relevance to exobiology and the origin of life on Earth are stressed. Author

**N93-18552*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**EUROPA: PROSPECTS FOR AN OCEAN AND EXOBIOLOGICAL IMPLICATIONS**

John Oro (Houston Univ., TX.), Steven W. Squyres (Cornell Univ., Ithaca, NY.), Ray T. Reynolds, and Thomas M. Mills (Houston Univ., TX.) *In its*

Exobiology in Solar System Exploration Aug. 1992 p 103-126 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

As far as we know, Earth is the only planet in our solar system that supports life. It is natural, therefore, that our understanding of life as a planetary phenomenon is based upon Earth-like planets. There are environments in the solar system where liquid water, commonly believed to be a prerequisite for biological activity, may exist in a distinctly non-Earth-like environment. One such location is Europa, one of the Galilean satellites of Jupiter. The possibility that liquid water exists on Europa presents us with some interesting exobiological implications concerning the potential of the satellite to support life. Topics include the following: an ocean on Europa; thermal evolution of Europa; Europa's three models; exobiological implications; early conditions of Europa; low-temperature abiotic chemistry; possibility of the emergence of life on Europa; prerequisites for the habitability of Europa; energy sources for biosynthesis and metabolic activity; habitability of Europa by anaerobic life; and habitability by aerobic life. Author

**N93-18553*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**TITAN**

Tobias Owen (Hawaii Univ., Honolulu.), Daniel Gautier (Observatoire de Paris-Meudon, France ), Francois Raulin (Paris Univ., Creteil, France ), and Thomas Scattergood *In its* Exobiology in Solar System Exploration Aug. 1992 p 127-144 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

The following topics are discussed with respect to Titan: observations of the atmosphere; laboratory simulations and theoretical models of Titan's atmosphere; endpoints of atmospheric chemistry - aerosols and oceans; exobiology; and the next steps in understanding Titan. Author

**N93-18554*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**COSMIC DUST** **c90**

Donald E. Brownlee (Washington Univ., Seattle.) and Scott A. Sandford *In its* Exobiology in Solar Research Exploration Aug. 1992 p 145-158 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

Dust is a ubiquitous component of our galaxy and the solar system. The collection and analysis of extraterrestrial dust particles is important to exobiology because it provides information about the sources of biogenically significant elements and compounds that accumulated in distant regions of the solar nebula and that were later accreted on the planets. The topics discussed include the following: general properties of interplanetary dust; the carbonaceous component of interplanetary dust particles; and the presence of an interstellar component. Author

**N93-18555*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**ORGANIC MATERIAL: ASTEROIDS, METEORITES, AND PLANETARY SATELLITES** **c90**

Dale P. Cruikshank and John F. Kerridge (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In its* Exobiology in Solar System Exploration Aug. 1992 p 159-176 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

Telescopic observations in in situ spacecraft investigations over the last two decades have shown that many planetary satellites, asteroids, and comets have surfaces containing very dark material that is either neutral (black) or red in color. Although comets are not the focus of this paper, the possible relationship of comets to asteroids, meteorites, and interplanetary dust is briefly discussed in the context of their dark-matter component. The following topics are discussed with respect to their organic content: carbonaceous chondrites; asteroids; low-albedo planetary satellites; and Pluto, Charon, and Triton. Laboratory studies and a summary are also presented. Author

**N93-18556*#** Toledo Univ., OH. Dept. of Physics and Astronomy.

**COMETS: ROLE AND IMPORTANCE TO EXOBIOLOGY** **c90**

Armand H. Delsemme *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 177-198 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

The transfer of organic compounds from interstellar space to the outskirts of a protoplanetary disk, their accretion into cometary objects, and the transport of the latter into the inner solar system by orbital diffusion throw a new light on the central problem of exobiology. It suggests the existence of a cosmic mechanism, working everywhere, that can supply prebiotic compounds to ubiquitous rocky planets, in search of the proper environment to start life in many places in the Universe. Under the heading of chemistry of the cometary nucleus, the following topics are covered: radial homogeneity of the nucleus; the dust-to-ice ratio; nature of the dust grains; origin of the dust in comets; nature of the volatile fraction; the CO distribution in comet Halley; dust contribution to the volatile fraction; elemental balance sheet of comet Halley; quantitative molecular analysis of the volatile fraction; and isotopic ratios. Under the heading of exogenous origin of carbon on terrestrial planets the following topics are covered: evidence for a high-temperature phase; from planetesimals to planets; a veneer of volatile and organic material; and cometary contribution. Author

**N93-18557*#** California Inst. of Tech., Pasadena. Div. of Geology and Planetary Sciences.

**MARS OBSERVER: MISSION TOWARD A BASIC UNDERSTANDING OF MARS** **c91**

Arden L. Albee *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 199-214 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

The Mars Observer Mission will provide a spacecraft platform about Mars from which the entire Martian surface and atmosphere will be observed and mapped by remote sensing instruments for at least 1 Martian year. The scientific objectives for the Mission emphasize qualitative and quantitative determination of the elemental and mineralogical composition of the surface; measurement of the global surface topography, gravity field, and magnetic field; and the development of a synoptic data base of climatological conditions. The Mission will provide basic global understanding of Mars as it exists today and will provide a framework for understanding its past. Author

**N93-18558*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**CRAF MISSION: AN OPPORTUNITY FOR EXOBIOLOGY** **c90**

Marcia Neugebauer and Paul Weissman *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 215-228 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

The Halley missions of 1986 gave us a first, quick glimpse of a comet nucleus and the first in situ measurements of cometary gas and dust. Many of our basic ideas about cometary nuclei were confirmed while a number of startling new discoveries were also made. However, in many respects the very fast Halley flybys raised more questions than they answered. We learned, for example, that comets contain a large amount of organic material but we were unable to determine precisely which organic molecules were present. We learned, too, that the nucleus of a comet is a dark, irregularly shaped body, but we could determine very little about the physical state and structure of the ices and grains within the comet nucleus. Author

**N93-18559*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**CASSINI: MISSION TO SATURN AND TITAN** **c91**

Stuart J. Kerridge (California Univ., Los Angeles.), Walter Flury (European Space Agency. European Space Operations Center, Darmstadt, Germany), Linda J. Horn (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), Jean-Pierre LeBreton (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ), Douglas S. Stetson, Richard L. Stoller, and Grace H. Tan *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 229-248 Original contains color illustrations (For primary document see N93-18545 06-51)

Avail: CASI HC A03/MF A03; 46 functional color pages

The Cassini Mission to Saturn and Titan represents an important step

into the exploration of the outerplanets. It will expand on the flyby encounters of Pioneer and Voyager and parallel the detailed exploration of the Jupiter system to be accomplished by the Galileo Mission. By continuing the study of the two giant planets and enabling detailed comparisons of their structure and behavior, Cassini will provide a tremendous insight into the formation and evolution of the solar system. In addition, by virtue of its focus on the Saturnian satellite Titan, Cassini will return detailed data on an environment whose atmospheric chemistry may resemble that of the primitive Earth. The scientific objectives can be divided into five categories: Titan, Saturn, rings, icy satellites, and magnetospheres. The key area of interest to exobiologists is Titan; the other four scientific categories will be discussed briefly to provide a comprehensive overview of the Cassini Mission. I.I.C.

**N93-18560*#** Geological Survey, Menlo Park, CA.
**MRSR: RATIONALE FOR A MARS ROVER/SAMPLE RETURN MISSION c91**

Michael H. Carr *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 249-262 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

The Solar System Exploration Committee of the NASA Advisory Council has recommended that a Mars Rover/Sample Return mission be launched before the year 2000. The recommendation is consistent with the science objectives as outlined by the National Academy of Sciences committees on Planetary and Lunar Exploration, and Planetary Biology and Chemical Evolution. Interest has also focused on Mars Rover/Sample Return (MRSR) missions, because of their crucial role as precursors for human exploration. As a result of this consensus among the advisory groups, a study of an MRSR mission began early in 1987. The study has the following goals: (1) to assess the technical feasibility of the mission; (2) to converge on two or three options for the general architecture of the mission; (3) to determine what new technologies need to be developed in order to implement the mission; (4) to define the different options sufficiently well that preliminary cost estimates can be made; and (5) to better define the science requirements. This chapter briefly describes Mars Rover/Sample Return missions that were examined in the late 1980s. These missions generally include a large (1000 kg) rover and return of over 5 kg of sample. M.G.

**N93-18561*#** National Aeronautics and Space Administration, Washington, DC.
**EXOBIOLOGY: THE NASA PROGRAM**

John D. Rummel, Lynn Harper (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.), and Dale Andersen (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 263-272 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A02/MF A03; 46 functional color pages

The goal of NASA's Exobiology Program is to understand the origin, evolution, and distribution of life in the universe. To do this, the Exobiology Program seeks to provide a critical framework and some key research to allow NASA to bear the combined talents and capabilities of the agency and the scientific community, and the unique opportunities afforded by space exploration. To provide structure and direction to the quest for answers, the Exobiology Program has instituted a comprehensive research program divided into four elements which are being implemented at several of NASA's research centers and in the university community. These program elements correspond to the four major epochs in the evolution of living systems: (1) cosmic evolution of the biogenic compounds; (2) prebiotic evolution; (3) origin and early evolution of life; and (4) evolution of advanced life. The overall research program is designed to trace the pathways leading from the origin of the universe through the major epochs in the story of life. Author

**N93-18562*#** National Aeronautics and Space Administration, Washington, DC.
**FUTURE NASA SOLAR SYSTEM EXPLORATION ACTIVITIES: A FRAMEWORK FOR INTERNATIONAL COOPERATION c12**

Bevan M. French, Terri Ramlose (Science Applications International Corp., Schaumburg, IL.), and Geoffrey A. Briggs (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 273-292 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

The goals and approaches for planetary exploration as defined for the NASA Solar System Exploration Program are discussed. The evolution of the program since the formation of the Solar System Exploration Committee (SSEC) in 1980 is reviewed and the primary missions comprising the program are described. Author

**N93-18608*#** University City Science Center, Philadelphia, PA.
**INVESTIGATION OF WHEAT COLEOPTILE RESPONSE TO PHOTOTROPIC STIMULATIONS Final Report, 1 Nov. 1989 - 31 Jan. 1993**

David G. Heathcote, Allen H. Brown, and David K. Chapman 31 Jan. 1993 34 p
(Grant NAG2-623)
(NASA-CR-192157; NAS 1.26:192157) Avail: CASI HC A03/MF A01

This report provides a summary of the preparations for, and the conduct and post-flight data analysis of, the Spacelab flight investigation FOTRAN, which flew on the IML-1 mission (STS-42) in January, 1992. The investigation was designed to provide data on the responses of wheat seedlings to various blue-light stimuli given while the plants were exposed to orbital microgravity conditions. Before the flight, a number of hypotheses were established which were to be tested by the data from the flight and parallel ground studies. A description of the experiment protocol developed for the mission is provided, and an account of the activities supported during preparations for and support of the flight experiment is given. Details of the methods used to reduce and analyze the data from the flight are outlined. Author

**N93-19037*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**HIGH DENSITY CELL CULTURE SYSTEM Patent Application**

Glenn Spaulding, inventor (to NASA) 23 Dec. 1992 15 p
(NASA-Case-MSC-22060-1; NAS 1.71:MSC-22060-1;
US-Patent-Appl-SN-996263) Avail: CASI HC A03/MF A01

An annular culture vessel for growing mammalian cells is constructed in a one piece integral and annular configuration with an open end which is closed by an endcap. The culture vessel is rotatable about a horizontal axis by use of conventional roller systems commonly used in culture laboratories. The end wall of the endcap has tapered access ports to frictionally and sealingly receive the ends of hypodermic syringes. The syringes permit the introduction of fresh nutrient and withdrawal of spent nutrients. The walls are made of conventional polymeric cell culture material and are subjected to neutron bombardment to form minute gas permeable perforations in the walls. NASA

**N93-19054*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ACTIVE SYNTHETIC SOIL Patent Application**

Douglas W. Ming, inventor (to NASA), Donald L. Henninger, inventor (to NASA), Earl R. Allen, inventor (to NASA) (Oklahoma State Univ., Stillwater.), and Dagigamuwage C. Golden, inventor (to NASA) (National Academy of Sciences - National Research Council, Houston, TX.) 16 Oct. 1992 26 p
(NASA-Case-MSC-21954-1-NP; NAS 1.71:MSC-21954-1-NP;
US-Patent-Appl-SN-963349) Avail: CASI HC A03/MF A01

A synthetic soil/fertilizer for horticultural application having all the agronutrients essential for plant growth is disclosed. The soil comprises a synthetic apatite fertilizer having sulfur, magnesium, and micronutrients dispersed in a calcium phosphate matrix, a zeolite cation exchange medium saturated with a charge of potassium and nitrogen cations, and an optional pH buffer. Moisture dissolves the apatite and mobilizes the nutrient elements from the apatite matrix and the zeolite charge sites. NASA

**N93-19377*#** University City Science Center, Philadelphia, PA. Gravitational Plant Physiology Lab.
**A PROPOSAL TO DETERMINE PROPERTIES OF THE GRAVITROPIC RESPONSE OF PLANTS IN THE ABSENCE OF A COMPLICATING g-FORCE (GTHRES) Final Report**

Allan H. Brown, David K. Chapman (Pennsylvania Univ., Philadelphia.),

David G. Heathcote, and Anders Johnsson (Trondheim Univ., Norway ) 31 Jan. 1993 39 p
(Grant NAG2-574)
(NASA-CR-192219; NAS 1.26:192219) Avail: CASI HC A03/MF A01

Gravitropic responses of oat seedlings (Avena sativa L.) were measured on Earth and in microgravity (IML-1). The seedlings were grown at 1 g either on Earth or on 1 g centrifuges. They were challenged by centripetal accelerations for which the intensity and duration of the stimulations were varied. All stimulation intensities were in the hypogravity region from 0.1 to 1.0 g. All responses occurred either in Spacelab microgravity or during clinorotation on Earth. The experiments were carried out with the same apparatus in Spacelab and on Earth. The experiments addressed a series of scientific questions and useful data were obtained to provide answers to some but not all of those questions. Author

**N93-19751#** Brookhaven National Lab., Upton, NY.
**THE EFFECTS OF PROLONGED GROWTH IN ELEVATED CO2 CONCENTRATIONS IN THE FIELD ON THE AMOUNTS OF DIFFERENT LEAF PROTEINS**
G. Y. Nie (Essex Univ., Colchester, England ) and S. P. Long (Essex Univ., Colchester, England ) Sep. 1992 6 p Presented at the 9th International Congress on Photosynthesis, Nagoya, Japan, 30 Aug. - 5 Sep. 1992
(Contract DE-AC02-76CH-00016)
(DE93-002940; BNL-48062; CONF-9208155-3) Avail: CASI HC A02/MF A01

Atmospheric CO2 concentration (C(sub a)) is expected to rise to double pre-industrial concentrations within the next century. Increased Ca may stimulate photosynthetic CO2 uptake (A) in C3 species because of the low affinity of Rubisco for CO2 and by inhibition of RubP oxygenation. Several controlled environment studies have suggested that this potential stimulation may be offset by decreased Rubisco contents and activities in leaves developed at elevated C(sub a), which can be related to decreased photosynthetic capacity in these leaves. This decreased capacity may be an artifact of restriction of below-ground organ development, and hence sink-capacity, imposed by pot size. Four species grown over two or more years in elevated C(sub a) in the field are used to address when changes in Rubisco content are also observed when plants are grown with elevated Ca in the field without restriction on rooting volume and whether Rubisco is the only major leaf protein to show change in quantity in plants grown in elevated c(sub a) over prolonged periods. DOE

**N93-19891*#** National Aeronautics and Space Administration, Washington, DC.
**REGULATORY PHYSIOLOGY DISCIPLINE SCIENCE PLAN**
1991 42 p
(NASA-TM-108038; NAS 1.15:108038) Avail: CASI HC A03/MF A01

The focus of the Regulatory Physiology discipline of the Space Physiology and Countermeasures Program is twofold. First, to determine and study how microgravity and associated factors of space flight affect the regulatory mechanisms by which humans adapt and achieve homeostasis and thereby regulate their ability to respond to internal and external signals; and, second, to study selected physiological systems that have been demonstrated to be influenced by gravity. The Regulatory Physiology discipline, as defined here, is composed of seven subdisciplines: (1) Circadian Rhythms, (2) Endocrinology, (3) Fluid and Electrolyte Regulation, (4) Hematology, (5) Immunology, (6) Metabolism and Nutrition, and (7) Temperature Regulation. The purpose of this Discipline Science Plan is to provide a conceptual strategy for NASA's Life Sciences Division research and development activities in the area of regulatory physiology. It covers the research areas critical to NASA's programmatic requirements for the Extended-Duration Orbiter, Space Station Freedom, and exploration mission science activities. These science activities include ground-based and flight; basic, applied, and operational; and animal and human research and development. This document summarizes the current status of the program, outlines available knowledge, establishes goals and objectives, identifies science priorities, and defines critical questions in regulatory physiology. It contains a general plan that will be used by both NASA Headquarters Program Offices and the field centers to review and plan basic, applied, and operational intramural and extramural research and development activities in this area. Author

**N93-19399*#** University of Central Florida, Orlando. Chemistry Dept.
**CHEMICAL CHARACTERIZATION OF SOME AQUEOUS LEACHATES FROM CROP RESIDUES IN 'CELSS'**
Brooks C. Madsen *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 229-259 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

## 52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N93-17817#** Army Aeromedical Research Lab., Fort Rucker, AL.
**EFFECTS OF TERFENADINE AND DIPHENHYDRAMINE ON BRAIN ACTIVITY AND PERFORMANCE IN A UH-60 FLIGHT SIMULATOR Final Report**
Robert L. Stephens, John A. Caldwell, Jr., Carlos A. Comperatore, Jacquelyn Y. Pearson, and Darcelle M. Delrie Sep. 1992 67 p
(AD-A258012; USAARL-92-33) Avail: CASI HC A04/MF A01

The effects of terfenadine, diphenhydramine, and a placebo on flight performance, resting electroencephalographic (EEG) activity, and auditory and visual evoked potential tasks were investigated. Twelve male Army aviators served as subjects in a double-blind, repeated measures experimental design. The results indicated that neither diphenhydramine nor terfenadine effected flight performance. Regarding resting EEG, diphenhydramine caused a decrease of alpha power at all electrode sites. For all sites with the exception of Cz, diphenhydramine also caused a decrease of power in the beta band. The P300 component-of the auditory evoked potential was unaffected by either of the drugs. The amplitude of the visual P300 was suppressed under diphenhydramine relative to placebo while the latency was unaffected. The results of this study highlight the importance of measuring multiple aspects of performance in assessing the impact of a drug. While flight performance was unaffected by either drug, the indications from measures of brain activity are that terfenadine is much less sedating. Therefore, it is a more attractive alternative for the treatment of allergic symptoms in the aviator population or in any population where compromised performance is potentially dangerous. GRA

**N93-17822#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**EFFECTS OF DEXTROMETHAMPHETAMINE ON SUBJECTIVE FATIGUE Interim Report**
C. A. DeJohn, S. A. Shappell, and D. F. Neri Aug. 1992 18 p
(AD-A258252; NAMRL-1376) Avail: CASI HC A03/MF A01

Declining aircrew performance during periods of sustained flight operations (SUSOP's) has underscored the need to develop effective countermeasures. This paper reports on the ability of the central nervous system (CNS) stimulant d-methamphetamine to alleviate the detrimental effects of a simulated SUSOP's on subjective fatigue. Subjective fatigue was repeatedly measured by three questionnaires. The simulated SUSOP started at 1800 and consisted of a 9-h planning session followed by 4 h of rest and a 14-h mission. After 6 h of sleep, the 9/4/14 work/rest/work pattern was repeated. At 4 1/2 h into the second mission, 13 subjects were administered 10 mg of d-methamphetamine/70 kg of body mass while 12 subjects received a placebo in a double-blind procedure. Administration of d-methamphetamine significantly reduced reported fatigue scores on the Addiction Research Center Inventory (ARCI), Mood Questionnaire (MQ), and sleepiness scores on the Stanford Sleepiness Scale (SSS). GRA

**N93-17895#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**AN AUTOMATED VERSION OF THE DICHOTIC LISTENING TEST: HARDWARE, SOFTWARE, AND PROCEDURAL DETAILS**
G. B. Thomas, A. H. McCardie, and D. H. Lewis Jul. 1992 20 p
(AD-A258114; NAMRL-TM-92-2) Avail: CASI HC A03/MF A01

Hardware, software, and procedural details are presented for creation of a personal computer-based dichotic listening test. The source code is in Microsoft QuickBasic 4.5 and incorporates subject instructions, a practice-to-criterion routine, and automated stimuli presentation and scoring. The original computer platform was an 80286-based computer with a VGA card but the code has been tested with 80386 and 80486 microprocessors

and various video modes with no problems. The stimuli are digitized analog signals and are presented through Antex processing cards. Source code and stimuli files are available from the authors. GRA

**N93-17896#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**THE DETECTION OF LATERAL MOTION BY US NAVY JET PILOTS**
Leonard A. Temme May 1992 16 p
(NR Proj. M00-96)
(AD-A258115; NAMRL-1368) Avail: CASI HC A03/MF A01

A lateral motion detection test as a vision standard for naval aircrew personnel selection is evaluated. The leftward and rightward threshold velocities of a 1.5-degree spot of light presented in an essentially empty visual field were measured in 110 U.S. Navy fighter pilots. These threshold measurements were compared to similar measurements of nonaviator subjects as reported in the literature. There was no evidence that pilots and non-pilots differed. Air-to-air target detection distances measured during air combat maneuver training were compared to the aviators' velocity thresholds. The statistical evidence of a relationship between the vision and the performance measure was ambiguous and most likely due to sampling effects. Correlation between pilot age and velocity thresholds was not statistically significant. This particular test of lateral motion holds little promise as a useful, practical tool for personnel selection. GRA

**N93-17900#** Letterman Army Inst. of Research, San Francisco, CA. Div. of Blood Research.
**SYSTEMIC AND PULMONARY HYPERTENSION AFTER RESUSCITATION WITH CELL-FREE HEMOGLOBIN Final Report**
John R. Hess, Victor W. Macdonald, and William D. Brinkley Jul. 1992 37 p
(AD-A258185; LAIR-471) Avail: CASI HC A03/MF A01

Human hemoglobin (Hb) and hemoglobin cross-linked between the alpha subunits with bis-(3,5-dibromosalicyl)fumarate (aaHb) were used to treat hemorrhagic shock in water-deprived swine. Water was withheld for 48 hours to induce a 10 percent loss of body mass, and 25 ml/kg of blood was removed over one hour to produce circulatory shock. Swine were resuscitated with Hb, aaHb, human serum albumin, or Ringer's lactate. Mild high-output renal failure was observed in the non-crosslinked Hb-treated animals but not in other groups. Swine treated with Hb and aaHb had increases in plasma creatine kinase and lactate dehydrogenase activity that was resolved by seven days. Both Hb- and aaHb-treated swine displayed marked elevations of mean blood pressure in the systemic (39 +/- 6 Torr) and pulmonary (20 +/- 6 Torr) circulations that continued over three hours and were associated with reduced cardiac output and a doubling of the systemic and pulmonary vascular resistance. Oxygen delivery was equivalent and the rate of correction of the lactic acidosis was equal in all groups. GRA

**N93-17918#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**A REVIEW OF MODELS OF THE HUMAN TEMPERATURE REGULATION SYSTEM Interim Report**
L. G. Meyer 18 Feb. 1992 57 p
(AD-A258023; NAMRL-MONOGRAPH-45) Avail: CASI HC A04/MF A01

Over the last 100 years, models of temperature regulation have improved our understanding of the body's response to cold as much as scientific experimentation. Models have taken many forms, that is, verbal, pictorial, mechanical, mathematical, and have always been used to predict the body's thermal behavior in changing environmental conditions. Some models have been based on experimental data and some on theories of thermodynamics. As science has advanced, models have become increasingly more complex. However, the use of powerful, high-speed computers has enabled simulations to achieve a formidable level of predictability. Despite the increasing number and sophistication of models of temperature regulation, we have not reached the point where the computer simulation predicts accurately and entirely the complex interactions of the human body. There are many gaps to be filled. This review highlights the development of different models of the biological process of temperature regulation. The objective is to demonstrate the remarkable achievements of models as contributions to the advancement of our knowledge of human temperature regulation, while, at the same time, suggest the need for more explicit and accurate models that include important and previously excluded interactions between physiological systems, such as the cardiovascular and endocrine systems. GRA

**N93-17926#** Naval Medical Research Inst., Bethesda, MD.
**STATISTICALLY BASED DECOMPRESSION TABLES 8: LINEAR-EXPONENTIAL KINETICS Technical Report, Aug. 1990 - Oct. 1991**
E. C. Parker, S. S. Survanshi, E. D Weathersby, and E. D. Thalmann Sep. 1992 62 p
(NR Proj. M00-99)
(AD-A257613; NMRI-92-73) Avail: CASI HC A04/MF A01

Probabilistic models applied to diving decompression data have been successful in describing decompression sickness (DCS) occurrence and even time of DCS occurrence. This study explores a class of models using linear as well as exponential gas exchange kinetics to provide slower tissue washout than previous models. The models consist of 3 or 4 kinetic compartments, each of which can employ purely exponential (EE) or mixed linear-exponential (LE) kinetics. The risk of DCS is obtained from the single or double integration of the sum of compartment over-pressures. The resulting four models, EE1, EE2, LE1, and LE2 cover a broad range of gas kinetic possibilities. The data used in fitting these models are compiled from U.S. Navy, Canadian, and British chamber dive trials. There are 799 different dive profiles, representing 2383 man-dives, with a DCS incidence of 5.8 percent (131 DCS cases, 75 marginal cases). Time of DCS occurrence information is included for all decompression sickness, maximum likelihood, probabilistic modelling, gas exchange kinetics. DCS and many marginal cases. Maximum Likelihood fitting of the four models to these data indicate LE1 to be the best fit. The LE1 Model is able to predict DCS occurrence in the fitted data, as categorized by type of dive profile, risk level, and time of DCS occurrence. LE1 is able to predict DCS occurrence well in most data not used for fitting, with the exception of profiles using high percentage O2 breathing mixtures and some repetitive profiles. GRA

**N93-17985#** Naval Medical Research and Development Command, Bethesda, MD.
**BEHAVIORAL EFFECTS OF HIGH PEAK POWER MICROWAVE PULSES: HEAD EXPOSURE AT 1.3 GHz**
J. A. DAndrea, B. L. Cobb, and J. C. Knepton, Jr. Aug. 1992 17 p
(AD-A258136; NAMRL-1372) Avail: CASI HC A03/MF A01

To investigate behavioral performance effects of localized exposure to the head of very high-peak-power microwaves, rhesus monkeys (Macaca mulatta) were trained on a vigilance task. The task consisted of responding on one lever for a variable interval (VI - 30s) schedule and then responding on a second lever for food pellet reward. Monkeys were exposed for 25 min to 1.3-GHz microwave energy pulsed at 7, 9, and 11 pps. The pulse duration was 7 microsec with a peak power of 3.06 MW. Microwaves were delivered to the posterior of the head by an open-end waveguide irradiator. Average specific absorption rate (SAR) in the head ranged from 16.0 to 35.0 W/kg. The microwave period was preceded by a 25-min pre-exposure period and followed by a 25-min post-exposure period, each separated by a 1-min extinction period. Response rate on the VI lever decreased only at 26.0 and 35.0 W/kg compared to sham exposure sessions. Reaction time and post-reinforcement pause were unchanged in the exposed conditions relative to shams. GRA

**N93-18006#** California Univ., Berkeley. School of Optometry.
**SPATIO-TEMPORAL MASKING: HYPERACUITY AND LOCAL ADAPTATION Final Report, 1 Jan. 1989 - 31 Jul. 1992**
Stanley A. Klein 8 Oct. 1992 9 p
(Grant AF-AFOSR-0238-89)
(AD-A257934; AFOSR-92-0950TR) Avail: CASI HC A02/MF A01

Four areas of research are presented. First, models of human vision were applied to image compression and image fidelity for both static and dynamic images. The role of the human observer in JPEG compression was clarified. The human observer's visual information capacity was calculated to be about 20 bits/sq min, substantially higher than previous estimates. New formulas were developed for the Fourier transform of JPEG basis functions. This connected JPEG quantization matrices to the human observer's contrast sensitivity function. Crawford masking was used to measure the visibility of lines and edges following abrupt luminance changes. The high frame rates produced higher temporal resolution than previous studies. A striking asymmetry between light and dark lines was found. Second, a robust test-pedestal framework was developed for modeling spatio-temporal vision with fewer assumptions than previous models. In

this framework motion processing and hyperacuity thresholds are directly related to contrast processing. Third, a number of studies on motion processing developed new limits on the human visual system's capabilities. Finally, in order to connect psychophysics results to underlying physiological mechanisms, new techniques were developed for nonlinear analysis and source localization of visual evoked potentials and other biopotentials. GRA

**N93-18108*** National Aeronautics and Space Administration, Washington, DC.
**AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 370)**
Jan. 1993 80 p
(NASA-SP-7011(370); NAS 1.21:7011(370)) Avail: CASI HC A05

This bibliography lists 219 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during Dec. 1992. Subject coverage includes: aerospace medicine and physiology, life support systems and man/system technology, protective clothing, exobiology and extraterrestrial life, planetary biology, and flight crew behavior and performance. Author

**N93-18159#** Air War Coll., Maxwell AFB, AL.
**A PARADIGM SHIFT IN AIR FORCE MEDICINE**
Edward A. Miller May 1992 45 p
(AD-A258334) Avail: CASI HC A03/MF A01

Air Force medicine has been utilizing a quality assurance (QA) program for little less than a decade. The momentous success of total quality management (TQM) in the industrial business is starting to spill over into the American medical business in the form of continuous quality improvement (CQI). A QA program is a mandated, externally driven reactive program which focuses on the provider and who did it. CQI in contrast is proactive, internally driven, fosters participation, and focuses on process improvement and what is wrong. QA programs are set up to identify those individuals who deviate far from the norm. CQI focuses on the norm and continuously improves the norm. My thesis is that Air Force medicine must transition from QA to CQI. GRA

**N93-18209#** Naval Health Research Center, San Diego, CA.
**MUSCLE GLYCOGEN, FIBER TYPE, AEROBIC FITNESS, AND ANAEROBIC CAPACITY OF WEST COAST US NAVY SEA-AIR-LAND PERSONNEL (SEALs) Final Report, Dec. 1990 - Nov. 1991**
Ira Jacobs, W. K. Prusaczyk, and Harold W. Goforth, Jr. Jul. 1992 31 p
(DA Proj. MM3-3-P-30)
(AD-A258364; NHRC-92-10) Avail: CASI HC A03/MF A01

Thirty-eight Navy SEALs performed aerobic fitness and maximal anaerobic capacity tests on a cycle ergometer. Lactic acid concentration was measured in blood samples taken during the aerobic fitness test. After recording prior dietary intake and physical activity, thirty-six subjects had biopsies taken from the vastus lateralis muscle. Biopsy results showed that SEALs averaged 55 percent fast twitch muscle fiber type. The muscle samples had a mean glycogen concentration of 404 +/- 128 mmol/kg. Biopsy results show that SEALs have an unremarkable fiber type composition and a muscle glycogen concentration that may put them at risk of insidious glycogen depletion over successive deployment days. Muscle glycogen concentration was significantly correlated with 2-day dietary carbohydrate (CHO) intake normalized for body weight. Blood lactate concentration during submaximal exercise suggests that SEALs' aerobic fitness was somewhat low; anaerobic capacity tests show that SEALs would benefit from: (1) increasing CHO intake to enhance premission muscle glycogen; and (2) engaging in combined aerobic/anaerobic training using established principles of mode specificity, frequency,intensity, and duration of exercise. GRA

**N93-18210#** Naval Health Research Center, San Diego, CA.
**THE US NAVY HEALTHY BACK PROGRAM: EFFECT ON BACK KNOWLEDGE AMONG RECRUITS Interim Report**
Susan I. Woodruff, Terry L. Conway, and Leon Bradway Aug. 1992 22 p
(DA Proj. M00-95)
(AD-A258368; NHRC-92-12) Avail: CASI HC A03/MF A01

To address the high prevalence and costs associated with low back pain, U.S. Navy physical therapists currently provide back injury prevention education to requesting commands in the form of the Healthy Back Program. Although the content of the Healthy Back Program has face validity and is similar to other back education interventions, no explicit evaluation of its effectiveness has been conducted. Because of the need to develop effective and practical health interventions, a formal study is needed. A broader evaluation study will make use of a longitudinal, treatment-control group design to test the effects of the Healthy Back Program on back injuries among Navy recruits. The primary purposes of the present study are as follows: (1) present findings examining the immediate effect of the Healthy Back Program in changing knowledge about back injury prevention, and (2) provide a baseline assessment of back problems among incoming recruits. Correlates of back pain also are examined to suggest factors that may be amenable to intervention. GRA

**N93-18211#** Marine Biological Lab., Woods Hole, MA.
**ABSTRACTS OF PAPERS PRESENTED AT THE ANNUAL MEETING OF THE SOCIETY OF GENERAL PHYSIOLOGISTS**
13 Sep. 1992 81 p Meeting held at Woods Hole, MA, 10-13 Sep. 1992
(AD-A257718) Avail: CASI HC A05/MF A01

Abstracts of the papers presented at the forty sixth annual meeting of the Society of General Physiologists are included. L.R.R.

**N93-18217#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**AVIATION MEDICINE RESEARCH: A HISTORICAL REVIEW Final Report**
R. E. Mitchell 18 Nov. 1992 51 p
(AD-A258198; NAMRL-SR92-3) Avail: CASI HC A04/MF A01

On July 26, 1988, the commanding officer established the Ashton Graybiel Lecture Series to honor the former scientific director of the Naval Aerospace Medical Research Laboratory. Like Dr. Graybiel, this lecture series is intended to stimulate and challenge conventional research interests in naval aviation and aerospace medicine. As a pioneer in the field of aviation medicine for over 40 years, Dr. Graybiel made many significant scientific contributions, which cannot be overstated. His world-renowned work advanced current aeromedical knowledge and established the reputation of this laboratory. Today, his expertise, foresight, and creativity remain as benchmarks in our aviation medicine research. We are committed to the same level of excellence in meeting the needs of the fleet that Dr. Graybiel accomplished during four decades of research. A historical review of aviation medicine research is presented by Dr. Robert E. Mitchell, Medical Corps, U.S. Navy. GRA

**N93-18223#** California Univ., Irvine. Dept. of Cognitive Sciences.
**CLASSIFICATION OF COMPLEX SOUNDS Semiannual Progress Report, 1 May - 31 Oct. 1992**
Bruce G. Berg 31 Oct. 1992 14 p
(Contract N00014-92-J-1164)
(AD-A258405) Avail: CASI HC A02/MF A01

We have identified at least two factors which characterize listeners' abilities to discriminate complex spectra. One is the ability to integrate information across different auditory channels. Using COSS analysis, we have found that good listeners show spectral weights that are close to optimal, whereas poor listeners show weights which deviate from optimal weights. A second factor is internal noise, that is, the inherent variability of listeners. We have developed a model which incorporates both factors. An important aspect of this model is that it has no free parameters. Estimates of spectral weights and internal noise are completely determined by a trial-by-trial analysis of the data. Predictions are very consistent with thresholds obtained in a profile analysis task. GRA

**N93-18252#** Lehigh Univ., Bethlehem, PA. Center for Solid State Studies.
**ELECTRICALLY MODIFIABLE NONVOLATILE SONOS SYNAPSES FOR ELECTRONIC NEURAL NETWORKS Final Report, 1 Sep. 1989 - 30 Sep. 1992**
Marvin H. White, Chun-Yu M. Chen, Margaret French, and Amit Banerjee 30 Sep. 1992 40 p
(Contract N00014-89-J-3149)
(AD-A258318) Avail: CASI HC A03/MF A01

This research addresses the implementation of an electronic element, which emulates the biological synaptic interconnection, in an artificial

electronic neural system. The basic interconnection, or the weight, consists of an electrically reprogrammable, nonvolatile, analog conductance which programs at 5V levels. In addition, the fabrication technology for this synaptic interconnection is compatible with existing CMOS VLSI processes. The attractive features of this synaptic weight will be discussed in this report. Furthermore, this report examines the material needs, the device structures, the use of the synaptic weights in a two-tap weight linear adaptive neural-like circuit and the issue of integrating both the synaptic weight elements and the peripheral circuit onto a single silicon wafer. GRA

**N93-18264#** Hahnemann Medical Coll. and Hospital, Philadelphia, PA. Dept. of Physiology and Biophysics.

**THE ROLE OF CENTRAL MONOAMINERGIC SYSTEMS IN AROUSAL AND SELECTIVE ATTENTION Final Technical Report, 1 Apr. 1988 - 31 Mar. 1992**

Barry D. Waterhouse 31 Mar. 1992 13 p

(Grant AF-AFOSR-0138-87)

(AD-A258500; AFOSR-92-0911TR) Avail: CASI HC A03/MF A01

The work described here is part of an ongoing set of studies aimed at characterizing the physiological actions and anatomical organization of the monoaminergic projection systems to the rat cerebral cortex. The underlying theme of this work is that the endogenous monoamines, norepinephrine (NE) and serotonin (5-HT), serve to modulate central neuronal responsiveness to afferent synaptic inputs and by so doing participate in the cognitive process of selective attention. Individual studies conducted during the period of support have investigated: 1) the effects of NE and 5-HT on postsynaptic membrane responses of cortical neurons (layers 2/3 and 5) to threshold and subthreshold level stimulation of synaptic input pathways; 2) the effects of NE and 5-HT on receptive field and tuning properties of rat and cat visual cortical neurons; 3) the distribution of locus coeruleus and dorsal raphe neurons that project to principal relay sites along the visual and somatosensory pathways in rats; and 4) the actions of cocaine on response properties of central neurons. Overall, these data provide further support for the contention that the diffusely distributed monoamine systems of the mammalian brain may enhance the performance of target neuronal circuits as a function of changing behavioral conditions. GRA

**N93-18280#** Naval Aerospace Medical Research Lab., Pensacola, FL.

**A COMPUTER-BASED VISUAL ANALOG SCALE**

C. A. DeJohn, M. J. Marr, E. A. Molina, and A. H. McCardie Jun. 1992 26 p

(NR Proj. M00-96)

(AD-A258152; NAML-TR-92-1) Avail: CASI HC A03/MF A01

Although substantial literature exists on visual analog scales (VAS), much is directed toward the clinical assessment of pain. As part of a Naval Aerospace Medical Research Laboratory (NAMRL) effort to investigate the chronopharmacokinetics of methamphetamine during simulated sustained flight operations we developed a computerized VAS to determine the intensity of subjective responses associated with the administration of the stimulant. With simple modifications to the program, the questionnaire could be modified and used to test subjects' responses to a number of drugs, with better resolution of response than hand-scored methods allow. GRA

**N93-18292#** Naval Aerospace Medical Research Lab., Pensacola, FL.

**THE EFFECT OF COMBAT ON THE WORK/REST SCHEDULES AND FATIGUE OF A-6 AND F-14 AVIATORS DURING OPERATION DESERT SHIELD/STORM Final Report**

David F. Neri and Scott A. Shappell Aug. 1992 29 p

(AD-A258146; NAMRL-1375) Avail: CASI HC A03/MF A01

During Operation Desert Shield/Storm, A-6 and F-14 aviators aboard USS AMERICA completed daily activity logs and provided subjective measures of fatigue. Aviators flew frequently at night during Desert Storm, but without substantial sleep-related fatigue or problems. A likely contributing factor was the large number of naval aviation assets brought into the combat theater, allowing workload to be shared and activity and rest times to be properly managed. However, raster plots of the data suggest that there may have been an additional contributing factor. The AMERICA travelled eastward from the east coast through seven time zones and became involved in combat shortly after arrival in the Red Sea. This pattern of travel may have given AMERICA's aircrew flying at night a significant advantage over those already operating in the area. If the circadian clocks of AMERICA's aircrew had not fully adapted to local time upon arrival, local night flights were closer to being evening flights on body time. Aircrew may not have been experiencing troughs in their circadian cycles during local night flights, at least for the early part of the war. This would result in a smaller physical challenge to overcome. This situation would likely not hold for aircrew who had been in the region for longer periods, nor would it occur for future conflicts closer to the originating time zone. We recommend the incorporation into battle strategy of information about the circadian phase of combatants (as well as sleep logistics) to help prepare them to fight at suboptimal times. GRA

**N93-18295#** Wisconsin Univ., Madison. Dept. of Medical Physics.

**X RAY SYSTEM, LIGHTWEIGHT MEDICAL (XRSLM) Final Report, 21 Dec. 1987 - 31 Mar. 1992**

Melvin P. Siedband, Frank C. Grenzow, Craig A. Heilman, and Robert C. Bruce 10 Aug. 1992 62 p

(Contract DAMD17-88-C-8058; DA Proj. 3M4-63807-D-836)

(AD-A258159) Avail: CASI HC A04/MF A01

The X-Ray System, Lightweight Medical (XRSLM) is intended for use as a general purpose x-ray system. The original concept was developed on an earlier contract, DAMD17-86C-6039. The system is compact and stored in four containers until ready for assembly. The system is powered by rechargeable NiCd cells or from 110 vac power lines. Unlike a conventional 10 kWp system, which would require line power capacity of 10 kW, the XRSLM requires less than 0.2 kW input power. Conventional battery-powered mobile x-ray machines, batmobiles, weigh about 350 kg while this design weighs less than 90 kg. Unlike most conventional mobile systems, the XRSLM uses a grid for the reduction of the effects of scattered radiation, automatic exposure control, and semi-automatic collimation to improve image quality and to reduce the exposure to both patient and operator. The XRSLM may be assembled, transported and positioned by one operator. It is designed for use with conventional radiolucent tables and litters or operated as a free-standing chest radiographic device. It may also be used with a chair for head and dental radiography. The mechanical configuration is similar to that of the Basic Radiological System (BRS) of the World Health Organization (WHO). GRA

**N93-18301#** Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.

**VALIDITY OF CLINICAL COLOR VISION TESTS FOR AIR TRAFFIC CONTROL SPECIALISTS Final Report**

Henry W. Mertens and Nelda J. Milburn Oct. 1992 14 p

(AD-A258219; DOT/FAA/AM-92/29) Avail: CASI HC A03/MF A01

An experiment on the relationship between aeromedical color vision screening test performance and performance on color-dependent tasks of Air Traffic Control Specialists was replicated to expand the data base supporting the job-related validity of the screening tests. The original experiment (Mertens, 1990; n=108), and the replication (n=136) involved a total of 121 normal trichromats, 31 simple and 44 extreme anamalous trichromats, and 48 dichromats; both protans and deutans were included. The simulations of ATCS color tasks which served as validation criteria were flight progress strips (en route centers), aircraft lights and the Aviation Signal Light indicator (ATC terminal operations), and color weather radar (flight service station and en route center facilities). The validities Kappa of aeromedical screening tests ranged from 0.44 to 0.91 for prediction of error-free performance on all color dependent tasks. The aeromedical screening tests were generally acceptable in terms of selecting individuals who did not make errors, but several tests had high false alarm rates. The high job-related validity of several aeromedical color vision tests was confirmed. GRA

**N93-18362#** Aerospace Medical Research Labs., Brooks AFB, TX.

**THE PROCEEDINGS OF THE HYPOBARIC DECOMPRESSION SICKNESS WORKSHOP Final Report**

Andrew A. Pilmanis Jun. 1992 632 p Workshop held in Brooks AFB, TX, 16-18 Oct. 1990

(AF Proj. 7930)

(AD-A257612; AL-SR-1992-0005) Avail: CASI HC A99/MF A06

Decompression sickness (DCS) is the clinical condition resulting from evolved inert gas bubbles in tissues caused by a reduction of environmental pressure. It is recognized that DCS continues to be an operational limitation in both aviation and space activities. Furthermore, it is expected that the

crews of the next generation of military aircraft will be exposed to even higher altitudes. In order to document the current understanding of altitude decompression sickness and ascertain the operational significance of this disease, a workshop was held at the USAF Armstrong Laboratory (AL) (formerly USAF School of Aerospace Medicine), Brooks Air Force Base, Texas, on 16-18 October 1990. The meeting was sponsored by: (1) USAF AL; (2) NASA Johnson Space Center; and (3) AF Office of Scientific Research, and was attended by over 50 participants representing the Department of Defense (DOD), NASA, and university researchers. The reported incidence of altitude DCS is likely inaccurate due to potential career consequences. Efforts toward reporting with impunity were recommended. It was emphasized that DCS should be viewed as an occupational illness in the same way we view other physiological responses to environmental stress. GRA

**N93-18363#** Maryland Inst. for Emergency Medical Services, Baltimore.
**DEVELOPMENT AND ENHANCEMENT OF A MODE OF PERFORMANCE AND DECISION MAKING UNDER STRESS IN A REAL LIFE SETTING Quarterly Report No. 6**
Colin F. Mackenzie 1 Nov. 1992 7 p
(Contract N00014-91-J-1540)
(AD-A257796) Avail: CASI HC A02/MF A01

The focus of the present quarter has been on using the scoring system identified in our last quarterly report. We have tested the stressor scoring system by analyzing video tapes of patient resuscitations that have high trauma indices. The trauma index is obtained by adding three independent variables of ASA, AIS and TAG together. We have abstracted physiological data that is outside the ranges of normality. We believe that physiological variables (heart rate, blood pressure etc.) outside the range of normality increase stress on the anesthesiologist managing the patient. To tell this hypothesis we are comparing the stressors scores during abnormal physiological data with those obtained in the same patients and with the same trauma resuscitation team when the vital signs were stabilized. In addition to establishing whether abnormal physiological data is associated with high stressor scores the comparisons between scores made before and after successful resuscitation will enable us to better characterize what is and what is not stressful we will also be comparing team communications before and after completion of resuscitation. GRA

**N93-18375*#** Office of Space Science and Applications, Washington, DC. Life Sciences Div.
**SPACE RADIATION HEALTH PROGRAM PLAN**
Nov. 1991 37 p
(NASA-TM-108036; NAS 1.15:108036) Avail: CASI HC A03/MF A01

The Space Radiation Health Program intends to establish the scientific basis for the radiation protection of humans engaged in the exploration of space, with particular emphasis on the establishment of a firm knowledge base to support cancer risk assessment for future planetary exploration. This document sets forth the technical and management components involved in the implementation of the Space Radiation Health Program, which is a major part of the Life Sciences Division (LSD) effort in the Office of Space Science and Applications (OSSA) at the National Aeronautics and Space Administration (NASA). For the purpose of implementing this program, the Life Sciences Division supports scientific research into the fundamental mechanisms of radiation effects on living systems and the interaction of radiation with cells, tissues, and organs, and the development of instruments and processes for measuring radiation and its effects. The Life Sciences Division supports researchers at universities, NASA field centers, non-profit research institutes and national laboratories; establishes interagency agreements for cooperative use and development of facilities; and conducts a space-based research program using available and future spaceflight vehicles. Author

**N93-18376*#** George Washington Univ., Washington, DC.
**PUBLICATIONS OF THE SPACE PHYSIOLOGY AND COUNTERMEASURES PROGRAM, CARDIOPULMONARY DISCIPLINE: 1980-1990**
Janet V. Powers, Janice Wallace-Robinson, Katherine J. Dickson, and Elizabeth Hess Nov. 1992 113 p
(Contract NASw-4324)
(NASA-CR-4475; NAS 1.26:4475) Avail: CASI HC A06/MF A02

A 10-year cumulative bibliography of publications resulting from research supported by the Cardiopulmonary Discipline of the Space Physiology and Countermeasures Program of NASA's Life Sciences Division is provided. Primary subjects included in this bibliography are Fluid Shifts, Cardiovascular Fitness, Cardiovascular Physiology, and Pulmonary Physiology. General physiology references are also included. Principal investigators whose research tasks resulted in publication are identified. Publications are identified by a record number corresponding with their entry in the Life Sciences Bibliographic Database, maintained at the George Washington University. Author

**N93-18381*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**TARGET FRAGMENTATION IN RADIOBIOLOGY**
John W. Wilson, Francis A. Cucinotta, Judy L. Shinn, and Lawrence W. Townsend Washington Feb. 1993 26 p Presented at the Investigators Meeting on Space Radiation Research, Houston, TX, 22-23 Apr. 1991
(RTOP 199-04-16-11)
(NASA-TM-4408; L-17138; NAS 1.15:4408) Avail: CASI HC A03/MF A01

Nuclear reactions in biological systems produce low-energy fragments of the target nuclei seen as local high events of linear energy transfer (LET). A nuclear-reaction formalism is used to evaluate the nuclear-induced fields within biosystems and their effects within several biological models. On the basis of direct ionization interaction, one anticipates high-energy protons to have a quality factor and relative biological effectiveness (RBE) of unity. Target fragmentation contributions raise the effective quality factor of 10 GeV protons to 3.3 in reasonable agreement with RBE values for induced micronuclei in bean sprouts. Application of the Katz model indicates that the relative increase in RBE with decreasing exposure observed in cell survival experiments with 160 MeV protons is related solely to target fragmentation events. Target fragment contributions to lens opacity given an RBE of 1.4 for 2 GeV protons in agreement with the work of Lett and Cox. Predictions are made for the effective RBE for Harderian gland tumors induced by high-energy protons. An exposure model for lifetime cancer risk is derived from NCRP 98 risk tables, and protraction effects are examined for proton and helium ion exposures. The implications of dose rate enhancement effects on space radiation protection are considered. Author

**N93-18596*#** Good Samaritan Hospital and Medical Center, Portland, OR. Clinical Vestibular Lab.
**ROLE OF ORIENTATION REFERENCE SELECTION IN MOTION SICKNESS Semiannual Status Report**
Robert J. Peterka and F. Owen Black Jul. 1992 6 p
(Grant NAG9-117)
(NASA-CR-191912; NAS 1.26:191912) Avail: CASI HC A02/MF A01

The overall objective of this proposal is to understand the relationship between human orientation control and motion sickness susceptibility. Three areas related to orientation control will be investigated. These three areas are (1) reflexes associated with the control of eye movements and posture, (2) the perception of body rotation and position with respect to gravity, and (3) the strategies used to resolve sensory conflict situations which arise when different sensory systems provide orientation cues which are not consistent with one another or with previous experience. Of particular interest is the possibility that a subject may be able to ignore an inaccurate sensory modality in favor of one or more other sensory modalities which do provide accurate orientation reference information. We refer to this process as sensory selection. This proposal will attempt to quantify subjects' sensory selection abilities and determine if this ability confers some immunity to the development of motion sickness symptoms. Measurements of reflexes, motion perception, sensory selection abilities, and motion sickness susceptibility will concentrate on pitch and roll motions since these seem most relevant to the space motion sickness problem. Vestibulo-ocular (VOR) and oculomotor reflexes will be measured using a unique two-axis rotation device developed in our laboratory over the last seven years. Posture control reflexes will be measured using a movable posture platform capable of independently altering proprioceptive and visual orientation cues. Motion perception will be quantified using closed loop feedback technique developed by Zacharias and Young (Exp Brain Res, 1981). This technique requires a subject to null out motions induced by the experimenter while being exposed to various confounding sensory orientation cues. A subject's sensory selection abilities will be measured by the magnitude and timing of his

reactions to changes in sensory environments. Motion sickness susceptibility will be measured by the time required to induce characteristic changes in the pattern of electrogastrogram recordings while exposed to various sensory environments during posture and motion perception tests. The results of this work are relevant to NASA's interest in understanding the etiology of space motion sickness. If any of the reflex, perceptual, or sensory selection abilities of subjects are found to correlate with motion sickness susceptibility, this work may be an important step in suggesting a method of predicting motion sickness susceptibility. If sensory selection can provide a means to avoid sensory conflict, then further work may lead to training programs which could enhance a subject's sensory selection ability and therefore minimize motion sickness susceptibility. Author

**N93-18952#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A TOPOSCOPIC INVESTIGATION OF BRAIN ELECTRICAL ACTIVITY INDUCED BY MOTION SICKNESS M.S. Thesis**

Dwight A. Roblyer Dec. 1992 186 p

(AD-A259024; AFIT/GSO/ENG/92D-03) Avail: CASI HC A09/MF A02

A toposcope was constructed as a new tool to study signal frequency and phase relationships in electroencephalogram (EEG) records collected while subjects were experiencing motion sickness. This new tool, named TOPOS, is a software-based, multi-featured version of Grey Walter and Harold Shipton's device which they first produced in the late 1940's. The TOPOS graphical display permits the study of instantaneous frequency relationships between the input channels and a reference signal of fixed or varying frequency. TOPOS adds a correlation grid to aid observers in detecting channel-to-reference correlation levels. Users can also vary several display parameters via menus to optimize the analysis environment. Sinusoidal test inputs of known frequency produced recognizable and predictable patterns on the TOPOS display, depending on the existing channel-to-reference frequency relationships. Motion-sickness-affected EEG was input to TOPOS in order to study the correlation between the displays of each channel and four separate references: a 1.5-Hz sinusoid, and three channels of the EEG itself. Rapidly varying correlations were observed in each case. GRA

**N93-19072#** Army Research Inst. of Environmental Medicine, Natick, MA.

**VALIDATION OF TWO TEMPERATURE PILL TELEMETRY SYSTEMS IN HUMANS DURING MODERATE AND STRENUOUS EXERCISE**

Lou A. Stephenson, Mark D. Quigley, Laurie A. Blanchard, Deborah A. Toyota, and Margaret A. Kolka Oct. 1992 86 p

(AD-A259068; USARIEM-T10-92) Avail: CASI HC A05/MF A01

Thermoregulatory strain occurs in soldiers during field and laboratory tests of military equipment and systems. In laboratory tests, either rectal or esophageal temperature of the volunteers is monitored to ensure that internal body temperature (core temperature) does not exceed safe clinical limits. Each of these core temperature indices is reproducible and not biased by environmental temperature; however, the slow response time of rectal temperature is well known. Esophageal temperature measurements are not used in the field, but are routinely used in laboratory tests which are concerned with the study of thermoregulation. Rectal temperature measurements are used as a index of core temperature in the field and in some types of laboratory studies of exercise and heat stress responses. In the field, it is not always practical to monitor core temperature because volunteers reject the use of rectal probes as a clinical thermometer or the current portable system requires that a medical observer be close to the volunteer at all times. This methodology interferes with field exercises and requires large numbers of medical observers. For example, a medical observer would effectively disrupt the military mission of a tank crew while he monitors the core temperature of each crew member. A solution to monitoring core temperature during field exercises would be to monitor core temperature at an accepted internal site and to transmit the core temperature responses some distance from the test using telemetry. In this way, the medical observer could communicate to the crew or individual when core temperature limits have been exceeded. Alternatively, the individual could carry a temperature telemetry data logger that contained an alarm which would be activated if a core temperature safety limit were exceeded during the field exercise. GRA

**N93-19369#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**RETINAL MODELING: SEGMENTING MOTION FROM SPATIO-TEMPORAL INPUTS USING NEURAL NETWORKS M.S. Thesis**

David E. Swanson Dec. 1992 188 p

(AD-A258854; AFIT/GSO/ENG/92D-04) Avail: CASI HC A09/MF A02

Two first-order, linear, time-varying, differential equations were applied to the task of segmenting motion from sequences of images. The equations are modified Grossberg formulas for long-term and short-term memory models characterizing the neurotransmitter and cell-activity levels of a synapse and neuron. How a two layered, sensory, neural network can be built is described using the equations to simulate the amacrine neurons of the retina. The model is defined using adaptive input nodes (adaptive model) and is compared to a similar model without these nodes (Ogmen and Gagne model). By replicating the basic amacrine neuron model to form both one- and two-dimensional arrays, a method was created for processing images over time and space. To simulate the veto effect observed in shunt inhibitory synaptic junctions, a nonrecurrent, asynchronous, inhibitory region in the receptive field of the amacrine neural model was applied. It is shown how this effects the performance of the model in one dimension. In two dimensions, the models' response to synthesized imagery (pristine) and to real, forward looking infrared radar (FLIR) images was investigated. The output of the models are further processed through two types of moving-average filters - causal and noncausal. GRA

**N93-19648*#** National Aeronautics and Space Administration, Washington, DC.

**CARDIOPULMONARY DISCIPLINE SCIENCE PLAN**

1991 29 p

(NASA-TM-108040; NAS 1.15:108040) Avail: CASI HC A03/MF A01

Life sciences research in the cardiopulmonary discipline must identify possible consequences of space flight on the cardiopulmonary system, understand the mechanisms of these effects, and develop effective and operationally practical countermeasures to protect crewmembers inflight and upon return to a gravitational environment. The long-range goal of the NASA Cardiopulmonary Discipline Research Program is to foster research to better understand the acute and long-term cardiovascular and pulmonary adaptation to space and to develop physiological countermeasures to ensure crew health in space and on return to Earth. The purpose of this Discipline Plan is to provide a conceptual strategy for NASA's Life Sciences Division research and development activities in the comprehensive area of cardiopulmonary sciences. It covers the significant research areas critical to NASA's programmatic requirements for the Extended-Duration Orbiter, Space Station Freedom, and exploration mission science activities. These science activities include ground-based and flight; basic, applied, and operational; and animal and human research and development. This document summarizes the current status of the program, outlines available knowledge, establishes goals and objectives, identifies science priorities, and defines critical questions in the subdiscipline areas of both cardiovascular and pulmonary function. It contains a general plan that will be used by both NASA Headquarters Program Offices and the field centers to review and plan basic, applied, and operational (intramural and extramural) research and development activities in this area. Author

**N93-19838#** Oak Ridge Associated Universities, Inc., TN.

**HEALTH EFFECTS OF LOW-FREQUENCY ELECTRIC AND MAGNETIC FIELDS**

Jun. 1992 379 p

(Contract DE-AC05-76OR-00033)

(DE93-005675; ORAU-92/F8) Avail: CASI HC A17/MF A03

The US Department of Labor and the President's Office of Science and Technology Policy (STP) requested that the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) conduct an independent evaluation of the reported health effects from exposure to low-frequency electric and magnetic fields (ELF-EMF), especially reports of carcinogenesis and reproductive and neurophysiological effects focusing on frequencies which appeared to be of greatest public concern. Oak Ridge Associated Universities (ORAU) was tasked by the CIRRPC to oversee the review by a panel of independent, non-Federal, scientists. Following their review of over 1000 journal articles, the ORAU Panel concluded ... that there is no convincing evidence ... to support the contention that exposure to ELF-EMF generated by sources such as household appliances,

video display terminals (10 to 30 KHz), and local power lines (15 to 180 Hz) are demonstrable health hazards. Although the Panel noted that some biological effects produced by these fields may be of scientific interest and warrant consideration for future research, it concluded that ... in the broad scope of research needs in basic science and health research, any health concerns over exposures to these fields should not receive a high priority. DOE

**N93-19882*#** National Aeronautics and Space Administration, Washington, DC.
**NEUROSCIENCE DISCIPLINE SCIENCE PLAN**
1991 25 p
(NASA-TM-108041; NAS 1.15:108041) Avail: CASI HC A03/MF A01

Over the past two decades, NASA's efforts in the neurosciences have developed into a program of research directed at understanding the acute changes that occur in the neurovestibular and sensorimotor systems during short-duration space missions. However, the proposed extended-duration flights of up to 28 days on the Shuttle orbiter and 6 months on Space Station Freedom, a lunar outpost, and Mars missions of perhaps 1-3 years in space, make it imperative that NASA's Life Sciences Division begin to concentrate research in the neurosciences on the chronic effects of exposure to microgravity on the nervous system. Major areas of research will be directed at understanding (1) central processing, (2) motor systems, (3) cognitive/spatial orientation, and (4) sensory receptors. The purpose of the Discipline Science Plan is to provide a conceptual strategy for NASA's Life Sciences Division research and development activities in the comprehensive area of neurosciences. It covers the significant research areas critical to NASA's programmatic requirements for the Extended-Duration Orbiter, Space Station Freedom, and exploration mission science activities. These science activities include ground-based and flight; basic, applied, and operational; and animal and human research and development. This document summarizes the current status of the program, outlines available knowledge, establishes goals and objectives, identifies science priorities, and defines critical questions in the subdiscipline areas of nervous system function. It contains a general plan that will be used by NASA Headquarters Program Offices and the field centers to review and plan basic, applied, and operational intramural and extramural research and development activities in this area. Author

**N93-19892*#** National Aeronautics and Space Administration, Washington, DC.
**MUSCULOSKELETAL DISCIPLINE SCIENCE PLAN**
1991 34 p
(NASA-TM-108039; NAS 1.15:108039) Avail: CASI HC A03/MF A01

Life sciences research in the musculoskeletal discipline must identify possible consequences of weightlessness on this system, understand the mechanisms of these effects, and develop effective and operationally practical countermeasures to protect crewmembers. The musculoskeletal system is highly plastic in that is possesses the inherent capability to adapt its structural and functional properties in accordance with the type and degree of stimuli imposed on it. Prolonged space travel is essentially a period of significant unloading of the musculoskeletal system. This results in adaptive responses in the structure and function of this system, placing it on the low end of a continuum from one of complete disuse to one of maximal use. There is a high probability that the musculoskeletal system is functionally impaired with increasing duration of weightlessness. The purpose of this Discipline Science Plan is to provide a conceptual strategy for NASA's Life Sciences division research and development activities in the area of musculoskeletal function. This document summarizes the current status of the program, outlines available knowledge, establishes goals and objectives, identifies science priorities, and defines research opportunities, which encompass critical questions in the subdiscipline areas (e.g., muscle, bone, and other musculoskeletal connective tissues). These science activities include ground-based and flight; basic, applied, and operational; and animal and human research and development. This document contains a general plan that will be used by both NASA Headquarters Program Offices and the field centers to review and plan basic, applied, and operational intramural and extramural research and development activities in this area. Author

**N93-19663#** Queens Medical Centre, Nottingham (England). Dept. of Orthopaedic and Accident Surgery.
**CAN INJURY SCORING TECHNIQUES PROVIDE ADDITIONAL INFORMATION FOR CRASH INVESTIGATORS?**
J. M. Rowles, W. A. Wallace, and D. J. Anton (Royal Aerospace Establishment Farnborough (England)) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 10 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19664#** Queens Medical Centre, Nottingham (England). Dept. of Orthopaedic and Accident Surgery.
**IS AXIAL LOADING A PRIMARY MECHANISM OF INJURY TO THE LOWER LIMB IN AN IMPACT AIRCRAFT ACCIDENT?**
J. M. Rowles, P. Brownson, W. A. Wallace, and D. J. Anton (Royal Aerospace Establishment Farnborough (England)) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19683#** German Air Force, Fuerstenfeldbruk (Germany).
**EFFECTS OF MEDIUM BLOOD ALCOHOL LEVELS ON PILOTS' PERFORMANCE IN THE SEA KING SIMULATOR MK-41**
M. Kraemer *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

**N93-19694#** Laboratoire de Medecine Aerospatiale, Bretigny-sur-Orge (France).
**FIRES ON BOARD AIRCRAFT: TOXICOLOGICAL RISK IN FLIGHT [INCENDIES A BORD DES AERONEFS: RISQUE TOXICOLOGIQUE EN VOL]**
M. Kerguelen, M. Mignet, and J. M. Jouany *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 12 p In FRENCH (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A03/MF A04

**N93-19695#** German Air Force, Fuerstenfeldbruk (Germany). Aviation Pathology Group.
**TOXICOLOGICAL INVESTIGATIONS OF FLIGHT ACCIDENTS: FINDINGS AND METHODS**
G. Powitz *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19696#** German Air Force, Fuerstenfeldbruk (Germany). Aerospace Pathology and Toxicology.
**27 YEARS ARMED FORCES AEROSPACE PATHOLOGY AND TOXICOLOGY IN THE FEDERAL REPUBLIC OF GERMANY: DEVELOPMENT, CURRENT STATUS, TRENDS AND CHALLENGES**
B. Mayr, G. Apel, and M. Kraemer *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

**N93-19697#** German Air Force, Fuerstenfeldbruk (Germany). Aerospace Pathology and Toxicology.
**SIGNIFICANCE OF HISTOLOGICAL POSTMORTEM FINDINGS IN PILOTS KILLED IN MILITARY AND CIVIL AIRCRAFT ACCIDENTS IN GERMANY (WEST): A 25-YEAR-REVIEW**
M. Kraemer and U. Stocker *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 5 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

**N93-19698#** Hellenic Air Force General Hospital, Athens (Greece).
**AIRCRAFT ACCIDENT INJURIES IN THE HELLENIC AIR FORCE IN THE LAST 20 YEARS**
Odysseas Paxinos *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

**N93-19707#** Paris V Univ. (France).
**STUDY OF THE SPECTRUM OF POWER OF CARDIAC RHYTHM DURING TASKS RELATING TO THE SAFETY OF THE CONTROL OF AN APPARATUS [ETUDE DU SPECTRE DE PUISSANCE DU RYTHME CARDIAQUE AU COURS DE TACHES RELATIVES A LA SECURITE DE LA CONDUITE DE L'APPAREIL]**
J. P. Fouillot, M. Benaoudia, P. Cabon, A. Benhalla, and A. Coblentz *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 1 p In FRENCH (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

**N93-19708#** Regie RENAULT, Nanterre (France).
**CONTRIBUTION OF THE ANALYSIS OF OCULAR ACTIVITY (COMPLEMENTARY TO THE ELECTROENCEPHALOGRAPHIC ANALYSIS) TO THE DETECTION OF LOW VIGILANCE IN INSTANCES OF PILOTING A VEHICLE [CONTRIBUTION DE L'ANALYSE DE L'ACTIVITE OCULAIRE (COMPLEMENTAIRE DE L'ANALYSE ELECTROENCEPHALOGRAPHIQUE) A LA DETECTION DES BAISSES DE VIGILANCE DANS LES TACHES DE PILOTAGE DE VEHICULE]**
C. Tarriere, S. Planque (Association pour la Recherche Interessant la Medicine du Travail, Paris, France ), C. Chabanon (Regie RENAULT, Aubevoye, France ), P. Artaud (Association pour la Recherche Interessant la Medicine du Travail, Paris, France ), and C. Lavergne (Association pour la Recherche Interessant la Medicine du Travail, Paris, France ) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p In FRENCH (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19710#** Gulhane Skeri Tip Akademisi, Eskisehir (Turkey). Aerospace Medical Center.
**EFFECTIVENESS OF BIRTHDATE BIORHYTHM THEORY ON FLIGHT ACCIDENTS**
Muzaffer Cetinguc, Umit Sarykayalar (Gulhane Skeri Tip Akademisi, Ankara, Turkey), and Kemal Savasan (Gulhane Skeri Tip Akademisi, Ankara, Turkey) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

## 53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N93-17816#** Washington Univ., Saint Louis, MO. Dept. of Psychology.
**ENHANCED PERFORMANCE USING PHYSIOLOGICAL FEEDBACK Final Technical Report, 28 May 1987 - 27 Nov. 1990**
John A. Stern, Robert Goldstein, and Richard Dobkin Oct. 1992 52 p
(Contract F33615-87-C-0603)
(AD-A258006; AL-TP-1992-0018) Avail: CASI HC A04/MF A01

Four studies are described designed to investigate (1) the use of blink variables to predict errors in vigilance performance, (2) the relationship between blink latency and decision making, (3) the factors affecting blink latency in a cognitive task, and (4) head and eye movements in acquiring peripheral information. In the first experiment, blinks were not found to be associated with error stimuli any more than they were with correct stimuli. The second experiment investigated the hypothesis that blink latency following a discriminative stimulus is a function of the time at which the decision could be made. Blink latency varied with the duration of the target stimulus, confirming the hypothesis. The third study investigated factors influencing the reduction in blink latency over trials. Components of the response sequence were isolated experimentally. Results suggested that the reduction in blink latency is due to an improvement in the implementation of the instructional rule. In the final study, head and eye movements were studied while subjects responded to peripheral stimuli. The proportion of the gaze shift accomplished by a head movement increased with task difficulty. Also, prior information about the time required by the task affected saccade latency to the peripheral stimulus. GRA

**N93-17820#** Boston Univ., MA. Center for Adaptive Systems.
**THE COGNITIVE, PERCEPTUAL, AND NEURAL BASES OF SKILLED PERFORMANCE Annual Technical Report, 15 Mar. 1991 - 14 Mar. 1992**
Stephen Grossberg Sep. 1992 66 p
(Grant AF-AFOSR-0175-90)
(AD-A258236; AFOSR-92-0976TR) Avail: CASI HC A04/MF A01

This report reviews progress from the Boston University, Northeastern University, and Harvard University/Cambridge University research groups of our AFOSR University Research Initiative grant. The report lists books and articles, summaries of research, and selected abstracts of key articles. The report also includes the program of an AFOSR-supported neural networks course and conference that were held at the Wang Institute of Boston University on May 5-12, 1991. The topic of the course was Neural Networks: From Foundations to Applications. Thirty-one lectures were given by ten lecturers. AFOSR helped to subsidize the student attendees. The topic of the conference was Neural Networks for Vision and Image Processing. There were sixteen invited speakers and forty-one contributed posters. Three hundred scientists and students attended from around the world. This conference was published as a book of the same name by the MIT Press in 1992. The Editorial Preface of the book is enclosed. The colloquium series speakers and topics of the Boston University URI component are also enclosed. GRA

**N93-17857#** Aerospace Medical Research Labs., Brooks AFB, TX.
**FLIGHT DIRECTOR INFORMATION AND PILOT PERFORMANCE IN INSTRUMENT APPROACHES Final Report, Apr. 1988 - Mar. 1991**
Rebecca B. Brooks, Harry D. Warner, David C. Hubbard, William E. Lincoln, and Gretchen M. Krueger-Anderson Aug. 1992 72 p
(AF Proj. 1123)
(AD-A258186; AL-TR-1992-0066) Avail: CASI HC A04/MF A01

This report documents the results of a research effort conducted to identify problem areas encountered during instrument approaches and landings in an F-16A through adverse meteorological conditions. Phase 1 consisted of identification and simulation of visual conditions likely to produce the conflict/misorientation experienced under 'real-world' conditions and development of performance measurement standards for F-16A instrument landing system (ILS) training. During phase 2, an experiment was conducted using the F-16A flight simulator at the Aircrew Training Research Division of the Armstrong Laboratory (AL/HRA) to evaluate F-16A pilot performance with five different ILS instrument configurations: (1) Head-up display (HUD) with flight director; (2) HUD without flight director; (3) panel instruments only; (4) panel instruments and head-down flight director; and (5) HUD with flight director, head-down flight director, and panel instruments. Normal aircraft configuration includes an ILS HUD display with flight director and cockpit panel instruments with raw ILS information. The head-down display, not found on the F-16A aircraft, was developed solely for the research. The display consisted of a head-down flight director that displayed computed steering commands from the HUD on the radar electro-optical display (REO). Twenty F-16A pilots with diverse levels of experience participated in this effort. Each pilot received 5 min of free flight and three practice approaches under benign visual flight rules (VFR) weather conditions. The pilot then flew 15 approaches (three under each condition, counterbalanced) under more difficult visual weather conditions which included scattered clouds, 1.5 mile-visibility, a 6000-ft ceiling, and a 15-knot crosswind. GRA

**N93-17919#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**THE EFFICACY OF BIOGRAPHICAL INVENTORY DATA IN PREDICTING EARLY ATTRITION IN NAVAL AVIATION OFFICER CANDIDATE TRAINING Interim Report, Jun. 1987 - Jan. 1990**
David R. Street, Jr. and Daniel L. Dolgin Aug. 1992 14 p
(NR Proj. M00-96)
(AD-A258025; NAMRL-1373) Avail: CASI HC A03/MF A01

Attrition in the training of U.S. naval aviation officer candidates represents a historic problem. The early identification of those likely to attrite during training would significantly reduce overall training expenditures. In this study, we assessed the value of biographical information for predicting early attrition at the indoctrination level of naval aviation officer training. We selected a random sample of 1551 aviation officer candidates and naval aviation cadets for analysis. The subjects selected had taken the Aviation Selection Test Battery (ASTB) between 1987 and 1990 and had completed the aviation indoctrination program operated by the Naval Aviation Schools Command in Pensacola, Florida. A principal component factor analysis of

Biographical Inventory items was conducted with those who passed (N = 1176) and also with those who attrited (N = 375) basic aviation indoctrination. The resultant factors were then forced into a discriminant function analysis to determine if the factors obtained were different for the two groups. We found that the factors were significantly different for the two groups. The results indicate that biographical data may be useful in identifying candidates who are most likely to attrite early from naval aviation training. GRA

**N93-17921#** Rice Univ., Houston, TX.
**COMPARING PERFORMANCE ON IMPLICIT MEMORY TESTS Final Technical Report, Aug. 1991 - Aug. 1992**
Henry L. Roediger, III 30 Sep. 1992 37 p
(Grant AF-AFOSR-0253-91)
(AD-A258168; AFOSR-92-0928TR) Avail: CASI HC A03/MF A01

AFOSR Grant 91-0253 supported four different lines of research, described herein. These are (1) a preliminary experiment to clarity our testing procedures; (2) experiments designed to examine effects of various types of repetition on several memory tests; (3) experiments designed to examine the effect of distinctive events on these tests; and (4) experiments designed to examine inhibition and spontaneous recovery in memory. The progress made on each topic is described. Briefly, all four lines of work have been carried to a successful completion, although in two cases (2 and 4) data are still being analyzed. Several publications from this research are either being published, written, or planned. GRA

**N93-18027#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**DUAL-TASK TRAINING STRATEGIES AND AGING M.S. Thesis**
Heather L. Pringle 1992 107 p
(AD-A258261; AFIT/CI/CIA-92-084) Avail: CASI HC A06/MF A02

The goal of this study was to examine whether or not variable priority training could be effectively used by the older population to improve performance on dual-tasks and whether or not this training transfers to different levels of complexity as well as to different tasks. The objective of variable priority training is to maintain the context of the complete task, while manipulating emphasis on each of the subtasks as a function of online feedback and experimenter instructions. Twenty-four subjects (ages 61 to 79) participated in ten sessions. Random assignment to either variable priority training (VP) or fixed priority training (FP) did not produce a gender balance. That non-withstanding, the results indicate that VP subjects had initial performance decrements related to the cost of learning a VP strategy. Once the strategy was mastered, however, VP subjects displayed learning where FP subjects did not. In transferring to new difficulty levels, no training advantages were evident. Variable priority training showed benefits in performance on novel tasks or novel additions to a learned task. GRA

**N93-18205#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**AN ANALYSIS OF A SUSTAINED FLIGHT OPERATION TRAINING MISSION IN NAVY ATTACK AIRCRAFT**
C. A. DeJohn and G. G. Reams Jun. 1992 16 p
(NR Proj. M00-96)
(AD-A258199; NAMRL-1370) Avail: CASI HC A03/MF A01

As part of a sustained flight operations (SUSOPs) research project, we had an opportunity to evaluate the performance of aircrews from three squadrons attached to Carrier Air Wing (CAW) 15. These squadrons were involved in a practice, long-range, overwater, strike mission from the USS CARL VINSON (CVN-70). At that time, the CARL VINSON was underway from Pearl Harbor, Hawaii, to Alameda, California. The purpose of this investigation was to evaluate performance changes during the simulated SUSOP. Pre- and postmission performance was compared using t tests, at the 95% confidence level. Results showed a significant improvement in the ability to perceive noise-degraded speech and a significant increase in carrier landing scores. No changes were found in cognitive performance on a computerized performance assessment battery (PAB). GRA

**N93-18273#** Dayton Univ., OH. Research Inst.
**AUTOMATIC INFORMATION PROCESSING AND HIGH PERFORMANCE SKILLS Final Report, Aug. 1988 - Jun. 1992**
F. T. Eggemeier and Arthur D. Fisk Oct. 1992 152 p
(Contract F33615-88-C-0015)
(AD-A258473; AL-TR-1992-0134) Avail: CASI HC A08/MF A02

A three-year research effort which investigated automatic processing theory and high performance skills training is sumarized. Issues pertaining to skill acquisition, transfer of training, skill retention, and operator workload were investigated with a variety of search and decision making tasks which were intended to represent laboratory analogs of some Command and Control (C2) operator functions. The results indicate that automatic processing can be developed with training in C2 task analogs, and suggest some conditions and limits on both the acquisition and transfer of automatic processing under conditions that are expected to be encountered within C2 systems. The results also indicate that there is minimal loss of automatic processing over retention intervals of up to one year, and demonstrate that the workload associated with task performance is reduced under automatic processing conditions. Performance principles and training guidelines that are based on the results of this effort are presented. GRA

**N93-18291#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**THE UNIQUE CONTRIBUTION OF SELECTED PERSONALITY TESTS TO THE PREDICTION OF SUCCESS IN NAVAL PILOT TRAINING**
D. R. Street, Jr., K. T. Helton, and D. L. Dolgin Aug. 1992 15 p
(AD-A258144; NAMRL-1374) Avail: CASI HC A03/MF A01

This study concerns the relationship of naval flight training performance to scores on the Aviation Qualification Test/Flight Aptitude Rating (AQT/FAR) and the automated Pilot Personality Questionnaire (PPQ). We analyzed a sample of 211 pilot candidates who had taken the AQT/FAR and PPQ. We found that the PPQ competitiveness scale and three of the AQT/FAR subtest score means were significantly different (p less than .05) for those who passed (N = 168) and those who attrited (N = 43) flight training. Discriminant analysis yielded a linear composite of the AQT/FAR and PPQ subtest variables that could be used to classify the students according to the likelihood of passing or attriting during flight training. The resulting discriminant function explained 9 percent of the variance in the pass/attrite criterion (r = .30). We found that a 50 percent reduction in attritions could be attained with a 23 percent increase in false rejections. The regression analysis was significant (p less than .01) and indicated that three scales of the PPQ and the AQT and FAR scores accounted for unique variance in a linear prediction equation. The FAR and PPQ competitiveness scale were the most powerful predictors of overall flight training success. GRA

**N93-18294#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**THE EFFECT OF COMBAT ON AIRCREW SUBJECTIVE READINESS AND LSO GRADES DURING OPERATION DESERT SHIELD/STORM Final Report**
Scott A. Shappell and David F. Neri May 1992 40 p
(NR Proj. MM3-3-P-30)
(AD-A258156; NAMRL-1369) Avail: CASI HC A03/MF A01

The effect of operational tasking on aircrew readiness during combat operations continues to be an area of intense investigation within the U.S. Navy. The recent Persian Gulf War provided a unique opportunity to collect data examining aircrew work/rest cycles and operational tasking in a combat environment. For 4 consecutive weeks during Operations Desert Shield and Desert Storm, 18 A-6 and 18 F-14 aviators onboard the USS AMERICA (CV-66) completed daily work/rest logs of their activities while conducting operations from the Red Sea. Activities on the work/rest logs were coded to a resolution of one-half hour. Several flight parameters were also obtained: (1) takeoff and landing time, (2) flight duration, (3) mission type, (4) consecutive days during which a flight occurred, (5) landing signal officer (LSO) scores, and (6) arresting wire engaged on landing. In addition, after each mission, aircrew provided a subjective assessment of the amount of time that they needed to rest before another air-to-ground strike mission could be flown (a measure of subjective readiness). Multiple regression analysis indicates that flight duration, the number of flights per day, and the time-of-day that the flight occurred, impact heavily on subjective evaluations of aircrew readiness. Few consistent relationships were observed between the independent measures and LSO grades. The data obtained here represent a unique look at aircrew work/rest patterns as they effect aircrew readiness during armed conflict. GRA

**N93-18298#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**A STUDY OF ILLNESS RELATED LOST TIME IN TRANSPORT AIRCRAFT CREWMEMBERS M.S. Thesis**
David J. Louis May 1992 62 p
(AD-A258193; AFIT/CI/CIA-92-89) Avail: CASI HC A04/MF A01

The purpose of this study was to determine if the illness rates of nonpilot air crewmembers are different from pilots. Interest in aircrew illness rates began when schedulers and flight surgeons noticed that frequently there were insufficient numbers of healthy flight engineers to staff the mission. When the literature on aircrew illness rates was reviewed, few studies were found. This study involved the compilation of illness data including the following: diagnosis job title (pilot (P), flight engineer (FE), loadmaster (L)); date of illness onset; and date of recovery for a military airlift wing in the southeastern United States over a two year period. Total time lost rates were calculated for each crew position for all illness and the seven most frequent diagnostic categories. Pilots were used as the comparison (referent) group. The database identified 1976 illnesses (events) in 569,969 person-days at risk. Time lost rates (days lost per 1000 person-days at risk) were significantly higher for flight engineers (56.2, p less than .001) and loadmasters (64.0, p less than .001) when compared to pilots (29.8). Incidence rates (new illness events per 1000 person-days at risk) were significantly higher for flight engineers (3.87, p less than .001) and loadmasters (4.07, p less than .001) than for pilots (2.76). Mean duration of illness was also longer for flight engineers at 8.4 days, and loadmasters at 9 days, than pilots at 6.6 days. GRA

**N93-18359*#** Columbia Univ., New York, NY.
**DECISION PATHS IN COMPLEX TASKS Final Technical Report**
Eugene Galanter 1991 9 p
(Grant NAGw-860)
(NASA-CR-192121; NAS 1.26:192121) Avail: CASI HC A02/MF A01

Complex real world action and its prediction and control has escaped analysis by the classical methods of psychological research. The reason is that psychologists have no procedures to parse complex tasks into their constituents. Where such a division can be made, based say on expert judgment, there is no natural scale to measure the positive or negative values of the components. Even if we could assign numbers to task parts, we lack rules i.e., a theory, to combine them into a total task representation. We compare here two plausible theories for the amalgamation of the value of task components. Both of these theories require a numerical representation of motivation, for motivation is the primary variable that guides choice and action in well-learned tasks. We address this problem of motivational quantification and performance prediction by developing psychophysical scales of the desireability or aversiveness of task components based on utility scaling methods (Galanter 1990). We modify methods used originally to scale sensory magnitudes (Stevens and Galanter 1957), and that have been applied recently to the measure of task 'workload' by Gopher and Braune (1984). Our modification uses utility comparison scaling techniques which avoid the unnecessary assumptions made by Gopher and Braune. Formula for the utility of complex tasks based on the theoretical models are used to predict decision and choice of alternate paths to the same goal. Author

**N93-18868#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.
**HUMAN PERFORMANCE ASSESSMENT METHODS [METHODES D'EVALUATION DE LA PERFORMANCE MENTALE]**
Eric Farmer, ed. 1991 10 p
(AGARD-AG-308-Add; ISBN-92-835-0600-6) Avail: CASI HC A02/MF A01

The purpose of this Addendum to AGARD-AG-308 is to provide changes and enhancements learned from AGARD Lecture Series 163. The Lecture Series occurred in June 1989 and was used to introduce the tests defined in AGARD-AG-308 to the international scientific community. The intent of Working Group 12, to make the AGARD STRES Battery an international standardized test battery, was supported by the success of Lecture Series 163. This Addendum provides additional information regarding the technical aspects of the STRES Battery and adds a section to Chapter 3 on Data Exchange Management. The information provided on Data Exchange Management will allow effective exchange on data and provide a mechanism for the process of evolution of the tests and refinement of their psychometric properties. Author

**N93-18949#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**THE EFFECTS OF ICONIC PRESENTATION ON INDIVIDUALS M.S. Thesis**
Ellen T. Barber and Elizabeth C. Dunn Sep. 1992 142 p
(AD-A258785; AFIT/GCA/LSY/92S-1) Avail: CASI HC A07/MF A02

This thesis investigated whether individuals interpreted iconic graphs differently than traditional graphs. A literature review revealed a lack of current research concerning iconic graphs. Using guidelines previously created for high-integrity graphics, a timed, pretest-posttest experiment was developed to compare the impressions rendered by both traditional and iconic graphs to determine whether men and women interpret the two types of graphs in the same way. It was also used to determine whether traditional bar graphs or iconic graphs were preferred by the subjects. Ninety-nine subjects, all employees of the Royal Australian Air Force/United States Air Force, or defense contractors, were involved in the experiment. Through the use of the Mann-Whitney U Test, it was determined that the method of presentation did not affect an individual's interpretation of the graph. Individuals did, however, prefer the traditional methods of presentation. It was also determined that gender did not have an affect on an individual's ability to interpret a graph. GRA

**N93-19449#** Naval Undersea Warfare Center, New London, CT.
**STIMULUS PRESENTATION FORMATS AND MEASUREMENT TECHNIQUES FOR THE QUANTIFICATION OF TARGET DETECTION PERFORMANCE Final Report**
W. R. Salafia and D. A. DaRos 6 Oct. 1992 29 p
(AD-A258933; NUWC-NL-TR-10193) Avail: CASI HC A03/MF A01

The forced-choice (FC) format for stimulus presentation and performance assessment has been gaining popularity over other formats in a variety of human performance tasks, such as target detection and acquisition. Laboratory experiments, comparison investigations, and system performance assessments that require statistical testing, for example sonar system MDL, have been reported in the literature with claims that use of the FC procedure leads-to simplification of data handling and increased cost-effectiveness. These and other claims are examined in the present report and a number of concerns are raised about the nature of the information acquired when the FC method is used for the quantification of performance in tasks that primarily involve vigilance, monitoring, and search behaviors. These concerns may be summarized as follows. First, the kinds of performance outcomes assessed using the FC format are often different from those assessed by continuous-search (CS) procedures. Second, the FC format holds some aspects of response bias constant, making it impossible to assess many variables that are of paramount importance in sonar system development, such as the effects on performance of signal probability, motivation, training, and experience. Third, the procedures have sometimes been misunderstood, and the term forced-choice has been misapplied to situations that technically are not FC. Finally, although there may be some valid practical reasons for using the FC format for stimulus presentation in final system performance evaluation, there is no compelling evidence that the method is superior to others in terms of data analysis, programming, or cost efficiency for the controlled laboratory experiment. GRA

**N93-19956#** Search Technology, Inc., Norcross, GA.
**MODELING THE DYNAMICS OF MENTAL WORKLOAD AND HUMAN PERFORMANCE IN COMPLEX SYSTEMS Final Report, 1 Sep. 1991 - 10 Aug. 1992**
William B. Rouse, Sharon L. Edwards, and John M. Hammer Aug. 1992 31 p
(Contract F33615-88-C-3612)
(AD-A258553; WL-TR-92-3095) Avail: CASI HC A03/MF A01

This program studied the relationship between subjective workload and human behavior and proposed a model of the dynamics of this relationship. Results of three simulation experiments are detailed in this report and show that simple linear identification algorithms are robust in online identification of noisy, nonlinear versions of the model. This model and the associated algorithms have the potential to enable online inferences of workload and could be used to prompt/invoke human aiding or automated systems to help reduce workload. Applications for such systems exist in aiding aircraft pilots; command, control, communication decision makers; and other personnel in dynamic, time constrained environments. GRA

**N93-19660#** Gulhane Skeri Tip Akademisi, Eskisehir (Turkey). Aerospace Medical Center.
**ASSESSMENT OF MORALE IN TURKISH AIR FORCE PILOTS WITH TWO CLINICAL PSYCHOLOGICAL TESTS**
Muzaffer Cetinguc, Sait Deger, and O. Yalug *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

**N93-19679#** Air Force Human Resources Lab., Brooks AFB, TX.
**EPIDEMIOLOGY OF UNITED STATES AIR FORCE SPATIAL DISORIENTATION ACCIDENTS: 1990-1991**
Terence J. Lyons, William R. Ercoline, James E. Freeman, and Kent K. Gillingham *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 11 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A03/MF A04

**N93-19680#** Army Air Corps, Stockbridge (England).
**DISORIENTATION AND FLIGHT SAFETY: A SURVEY OF UK ARMY AIRCREW**
S. J. Durnford *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 14 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A03/MF A04

**N93-19681#** Sextant Avionique, Saint Medard en Jalles (France).
**OTOLITHIC ILLUSIONS ON TAKEOFF AND VISUAL INFORMATION: REFLECTIONS IN CONNECTION WITH AN AIR ACCIDENT CASE [ILLUSIONS OTOLITHIQUES AU DECOLLAGE ET INFORMATIONS VISUELLES: REFLEXIONS A PROPOS D'UN CAS D'ACCIDENT AERIEN]**
A. Leger, C. Martin, and R. Parus *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p In FRENCH (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19682#** Centre d'Enseignement et de Recherches des Industries Alimentaires et Chimiques, Brussels (Belgium).
**COGNITIVE FACTORS IN THE AIR EVENTS OF THE AIR FORCE DURING THE LAST DECADE [LES FACTEURS COGNITIFS DANS LES EVENEMENTS AERIENS DE L'ARMEE DE L'AIR AU COURS DE LA DERNIERE DECENNIE]**
J. Y. Grau, R. Amalberti, and J. P. Menu *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p In FRENCH (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19703#** Naval Aerospace Medical Research Lab., Pensacola, FL. Naval Aerospace Medical Inst.
**MEDICAL EVALUATION OF SPATIAL DISORIENTATION MISHAPS**
A. Rupert, F. E. Guedry, and J. Clark *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 5 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

**N93-19705#** Hopital Ambroise Pare, Boulogne-Billancourt (France).
**THE INFLUENCE OF INDIVIDUAL SENSIVITY TO STRESS ON THE BEHAVIOR (ATTITUDE AND PERFORMANCE) OF AVOIDANCE OF AN ACCIDENT [INFLUENCE DE LA SENSIBILITE INDIVIDUELLE AU STRESS SUR LE COMPORTEMENT (ATTITUDE ET PERFORMANCE) D'EVITEMENT D'ACCIDENT]**
Claire Petit, Alain Priez (Hopital Raymond Poincare, Garches, France ), Claude Tarriere (Centre National de la Recherche Scientifique, Lyon, France), Andre Dittmar (Centre National de la Recherche Scientifique, Lyon, France), and Evelyne Vernet-Maury *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p In FRENCH (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19709#** Gulhane Skeri Tip Akademisi, Eskisehir (Turkey).
**GREMLINS: A DOZEN HAZARDOUS THOUGHT AND BEHAVIOR PATTERNS AS RISK FACTORS**
Muzaffer Cetinguc *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 4 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

**N93-17970*#** Texas Univ., Austin. Mechanical Engineering Design Projects Program.
**DESIGN OF A VIBRATION ISOLATION SYSTEM FOR A CYCLE ERGOMETER TO BE USED ONBOARD THE SPACE SHUTTLE Final Report**
Lillian Pearson, Steven Tait, and Maurice Trevino 1991 157 p
(Contract NASw-4435)
(NASA-CR-192021; NAS 1.26:192021) Avail: CASI HC A08/MF A02

Low frequency vibrations generated during exercise using the cycle ergometer onboard the Space Shuttle are disrupting sensitive microgravity experiments. The design team is asked by NASA/USRA to generate alternatives for the design of a vibration isolation system for the cycle ergometer. It is the design team's objective to present alternative designs and a problem solution for a vibration isolation system for an exercise cycle ergometer to be used onboard the Space Shuttle. In the development of alternative designs, the design team emphasizes passive systems as opposed to active control systems. This decision is made because the team feels that passive systems are less complex than active control systems, external energy sources are not required, and mass is reduced due to the lack of machinery such as servomotors or compressors typical of active control systems. Eleven alternative designs are developed by the design team. From these alternatives, three active control systems are included to compare the benefits of active and passive systems. Also included in the alternatives is an isolation system designed by an independent engineer that was acquired late in the project. The eight alternatives using passive isolation systems are narrowed down by selection criteria to four considered to be the most promising by the design team. A feasibility analysis is performed on these four passive isolation systems. Based on the feasibility analysis, a final design solution is chosen and further developed. From the development of the design, the design team has concluded that passive systems are not effective at isolating vibrations for the low frequencies considered for this project. Recommendations are made for guidelines of passive isolation design and application of such systems.
Author

**N93-17971*#** Kansas State Univ., Manhattan. Dept. of Mechanical Engineering.
**AUTOMATION OF CLOSED ENVIRONMENTS IN SPACE FOR HUMAN COMFORT AND SAFETY Report, 1991-1992**
1 Jun. 1992 122 p
(Contract NASw-4435)
(NASA-CR-192045; NAS 1.26:192045) Avail: CASI HC A06/MF A02

This report culminates the work accomplished during a three year design project on the automation of an Environmental Control and Life Support System (ECLSS) suitable for space travel and colonization. The system would provide a comfortable living environment in space that is fully functional with limited human supervision. A completely automated ECLSS would increase astronaut productivity while contributing to their safety and comfort. The first section of this report, section 1.0, briefly explains the project, its goals, and the scheduling used by the team in meeting these goals. Section 2.0 presents an in-depth look at each of the component subsystems. Each subsection describes the mathematical modeling and computer simulation used to represent that portion of the system. The individual models have been integrated into a complete computer simulation of the CO2 removal process. In section 3.0, the two

simulation control schemes are described. The classical control approach uses traditional methods to control the mechanical equipment. The expert control system uses fuzzy logic and artificial intelligence to control the system. By integrating the two control systems with the mathematical computer simulation, the effectiveness of the two schemes can be compared. The results are then used as proof of concept in considering new control schemes for the entire ECLSS. Section 4.0 covers the results and trends observed when the model was subjected to different test situations. These results provide insight into the operating procedures of the model and the different control schemes. The appendix, section 5.0, contains summaries of lectures presented during the past year, homework assignments, and the completed source code used for the computer simulation and control system. Author

**N93-17973*#** Texas Univ., Austin. Dept. of Mechanical Engineering.
**DESIGN OF A REUSABLE KINETIC ENERGY ABSORBER FOR AN ASTRONAUT SAFETY TETHER TO BE USED DURING EXTRAVEHICULAR ACTIVITIES ON THE SPACE STATION Final Report**
Dawn E. Borthwick, Daniel F. Cronch, and Glen R. Nixon 1991 158 p
(Contract NASw-4435)
(NASA-CR-192015; NAS 1.26:192015) Avail: CASI HC A08/MF A02

The goal of this project is to design a reusable safety device for a waist tether which will absorb the kinetic energy of an astronaut drifting away from the Space Station. The safety device must limit the tension of the tether line in order to prevent damage to the astronaut's space suit or to the structure of the spacecraft. The tether currently used on shuttle missions must be replaced after the safety feature has been developed. A reusable tether for the Space Station would eliminate the need for replacement tethers, conserving space and mass. This report presents background information, scope and limitations, methods of research and development, alternative designs, a final design solution and its evaluation, and recommendations for further work. Author

**N93-18018*#** Texas Univ., Austin. Dept. of Mechanical Engineering.
**CONCEPTUAL DESIGN OF A FLEET OF AUTONOMOUS REGOLITH THROWING DEVICES FOR RADIATION SHIELDING OF LUNAR HABITATS Supplemental Report**
Karem Armstrong, Daniel A. McAdams, and Jeffery L. Norrell 1992 41 p Sponsored by NASA. Johnson Space Center
(NASA-CR-192030; NAS 1.26:192030) Avail: CASI HC A03/MF A01

This report presents refinements in two areas of the initial design presented in the report entitled 'Conceptual Design of a Fleet of Autonomous Regolith Throwing Devices for Radiation Shielding of Lunar Habitats'. The first section presents an evaluation of the critical areas of the design and presents alternative solutions for these areas. The areas for design refinement are the traction required by the device and the stability of the device when throwing regolith. Several alternative methods are presented to solve these problems. First, the issue of required traction is covered. Next, the design is refined to provide a more stable device. The issue of stability is addressed both by presenting solutions for the configuration chosen for the computer simulation and by presenting two more device configurations. The next section presents the selected solutions. To prevent inadequate traction, the depth of dig-per-pass is reduced. A method combining a dynamic counterweight and an outrigger is chosen to provide a stable device. Author

**N93-18019*#** Texas Univ., Austin.
**PRELIMINARY DESIGN OF A RADIATOR SHADING DEVICE FOR A LUNAR OUTPOST**
Carlos Barron, Norma I. Castro, and Brian Phillips 1991 143 p
(Contract NASw-4435)
(NASA-CR-192016; NAS 1.26:192016) Avail: CASI HC A07/MF A02

The National Aeronautics and Space Administration is designing a thermal control system for an outpost to be placed permanently on the Moon. One of the functions of the thermal control system is to reject waste heat, which can be accomplished through a radiator. At the lunar equator and during the lunar midday, an unshaded radiator absorbs more heat than it rejects. This problem can be solved by using a shading device to reduce radiation incident on the radiator. The design team was asked to develop concepts for reducing the radiation incident on the radiator and for deploying the radiator and shade system for a 10 kW and a 25 kW heat rejection system. The design team was also asked to develop the best concepts into preliminary design. From the several alternatives developed by the design team, the best one was selected using a decision matrix. Preliminary design of the best concept include support structure, stress analyses, and thermal performance. In addition, the team developed ideas for removing lunar dust from the shading device. The final design solution consisted of a winged radiator shading system with a rail support structure and a scissors mechanism for deployment. The total radiator area required was calculated to be 389 sq m for the 10 kW heat rejection system and 973 sq m for the 25 kW heat rejection system. Author

**N93-18029#** Dayton Univ. Research Inst., OH.
**HELMET-MOUNTED AREA-OF-INTEREST DISPLAY Final Report, Oct. 1990 - Mar. 1991**
George R. Kelly, Martin Shenker, and Paul Weissman Oct. 1992 37 p
(Contract F33615-90-C-0005)
(AD-A258275; AL/HRA-TR-1992-0119) Avail: CASI HC A03/MF A01

This report describes the results of a design study for a helmet-mounted display (HMD) for use as an area of interest (AOI) for the Display for Advanced Research and Training (DART). The objective of the research was to investigate alternative optical approaches for building a helmet-mounted area of interest (HMAOI) for the DART and to recommend the optimal approach based on performance and cost tradeoffs. The experiment examined several system design problems: the design of an HMD eyepiece with minimal obtrusiveness, visual blending of the HMD imagery with the projected imagery, and timing and perspective issues relating to the computer-generated imagery presented by both the HMD and the projection display. GRA

**N93-18035#** Massachusetts Inst. of Tech., Cambridge.
**DESIGN REQUIREMENTS FOR FORCE REFLECTING MASTER CONTROLLERS**
M. Srinivassen 2 Nov. 1992 14 p
Avail: CASI HC A03/MF A01

The design criteria imposed by the capabilities of the human user on the design of force reflecting controllers for hands and arms are discussed. This paper contains four sections. First, we present a framework of questions regarding human capabilities. Second, a subset of the criteria is selected as the critical task set. Third, values for this task set are either presented or engineering experiments for determining the values are given. Lastly, the relationship between the critical task set and the engineering specifications for the machine are given. The framework discusses in a broad way all of the kinesthetic, kinematic, and tactile capabilities of the human hand and arm. A machine which met or exceeded all of these capabilities would present a true virtual reality interface. Many of these criteria cannot be met with current technologies. Therefore, the critical sensing/actuation dimensions for performing a set of tasks on a task board must be determined. We present a hypothesized set of criteria based on experience and the literature, and discuss some simple experiments that can be used to clarify the selection. For all of the capabilities, we present values that are available in the literature. The source of each value is referenced, and the experiment is briefly summarized and critiqued. For critical capabilities with unknown values, we have designed some engineering experiments to determine the values. In the design of the machine, only a subset of the human capability criteria are important in determining engineering design specifications. For instance, force threshold without any bias load determines the maximum reflected force that the mechanism can apply in free motion mode. This in turn determines the friction that can be tolerated in the design. We present the important engineering design parameters, and show how these can be determined from the human capabilities. Author

**N93-18111*#** Bionetics Corp., Cocoa Beach, FL.
**CHARACTERIZATION OF THE WATER SOLUBLE COMPONENT OF INEDIBLE RESIDUE FROM CANDIDATE CELSS CROPS**
Jay Garland Dec. 1992 21 p
(Contract NAS10-11624)
(NASA-TM-107557; Rept-92-TM-02; NAS 1.15:107557) Avail: CASI HC A03/MF A01

Recycling of inorganic nutrients required for plant growth will be a necessary component of a fully closed, bioregenerative life support system. This research characterized the recovery of plant nutrients from the inedible fraction of three crop types (wheat, potato, and soybean) by soaking, or

leaching, in water. A considerable portion of the dry weight of the inedible biomass was readily soluble (29 percent for soybean, 43 percent for wheat, and 52 percent for potato). Greater weight loss from potato was a result of higher tissue concentrations of potassium, nitrate, and phosphate. Approximately 25 percent of the organic content of the biomass was water soluble, while the majority of most inorganic nutrients, except for calcium and iron, were recovered in the leachate. Direct use of the leachates in hydroponic media could provide between 40-90 percent of plant nutrient demands for wheat, and 20-50 percent of demand for soybean and potato. Further evaluation of leaching as a component of resource recovery scheme in a bioregenerative system requires study of (1) utilization of plant leachates in hydroponic plant culture; and (2) conversion of organic material (both soluble and insoluble) into edible, or other useful, products. Author

**N93-18113*#** Texas Univ., Austin.
**CONCEPTUAL DESIGN OF A THERMAL CONTROL SYSTEM FOR AN INFLATABLE LUNAR HABITAT MODULE Final Report**
Ketan Gadkari, Sanjay K. Goyal, and Joseph Vanniasinkam 1991 238 p
(Contract NASw-4435)
(NASA-CR-192014; NAS 1.26:192014) Avail: CASI HC A11/MF A03

NASA is considering the establishment of a manned lunar base within the next few decades. To house and protect the crew from the harsh lunar environment, a habitat is required. A proposed habitat is an spherical, inflatable module. Heat generated in the module must be rejected to maintain a temperature suitable for human habitation. This report presents a conceptual design of a thermal control system for an inflatable lunar module. The design solution includes heat acquisition, heat transport, and heat rejection subsystems. The report discusses alternative designs and design solutions for each of the three subsystems mentioned above. Alternative subsystems for heat acquisition include a single water-loop, a single air-loop, and a double water-loop. The vapor compression cycle, vapor absorption cycle, and metal hydride absorption cycle are the three alternative transport subsystems. Alternative rejection subsystems include flat plate radiators, the liquid droplet radiator, and reflux boiler radiators. Feasibility studies on alternatives of each subsystem showed that the single water-loop, the vapor compression cycle, and the reflux boiler radiator were the most feasible alternatives. The design team combined the three subsystems to come up with an overall system design. Methods of controlling the system to adapt it for varying conditions within the module and in the environment are presented. Finally, the report gives conclusions and recommendations for further study of thermal control systems for lunar applications. Author

**N93-18153*#** Texas Univ., Austin. Dept. of Aerospace Engineering.
**SHARC: SPACE HABITAT, ASSEMBLY AND REPAIR CENTER**
Todd Colangelo, Debora Hoetger, Addison Kuo, Michael Lo, Leland Marcus, Philip Tran, Chris Tutt, Chad Wassmuth, and Gregory Wildgrube 15 May 1992 136 p Sponsored in cooperation with USRA
(Contract NASw-4435)
(NASA-CR-192031; NAS 1.26:192031) Avail: CASI HC A07/MF A02

Integrated Space Systems (ISS) has taken on the task of designing a Space Habitat, Assembly and Repair Center (SHARC) in Low Earth Orbit to meet the future needs of the space program. Our goal is to meet the general requirements given by the 1991/1992 AIAA/LORAL Team Space Design competition with an emphasis on minimizing the costs of such a design. A baseline structural configuration along with preliminary designs of the major subsystems was created. Our initial mission requirements, which were set by AIAA, were that the facility be able to: support simultaneous assembly of three major vehicles; conduct assembly operations and minimal extra vehicular activity (EVA); maintain orbit indefinitely; and assemble components 30 feet long with a 10 foot diameter in a shirtsleeve environment. Author

**N93-18156*#** Wisconsin Univ., Milwaukee. Space Architecture Design Group.
**PAX PERMANENT MARTIAN BASE: SPACE ARCHITECTURE FOR THE FIRST HUMAN HABITATION ON MARS, VOLUME 5**
Janis Huebner-Moths, Joseph P. Fieber, Patrick J. Rebholz, Kerry L. Paruleski, and Gary T. Moore, ed. 24 Jun. 1992 83 p *Its* Space Architecture Monograph Series
(Contract NASw-4435)
(NASA-CR-192042; NAS 1.26:192042) Avail: CASI HC A05/MF A01

America at the Threshold: Report of the Synthesis Group on America's Space Exploration Initiative (the 'Synthesis Report,' sometimes called the Stafford Report after its astronaut chair, published in 1991) recommended that NASA explore what it called four 'architectures,' i.e., four different scenarios for habitation on Mars. The Advanced Design Program in Space Architecture at the University of Wisconsin-Milwaukee supported this report and two of its scenarios--'Architecture 1' and 'Architecture 4'--during the spring of 1992. This report investigates the implications of different mission scenarios, the Martian environment, supporting technologies, and especially human factors and environment-behavior considerations for the design of the first permanent Martian base. The report is comprised of sections on mission analysis, implications of the Martian atmosphere and geologic environment, development of habitability design requirements based on environment-behavior and human factors research, and a full design proposed (concept design and design development) for the first permanent Martian base and habitat. The design is presented in terms of a base site plan, master plan based on a Mars direct scenario phased through IOC, and design development details of a complete Martian habitat for 18 crew members including all laboratory, mission control, and crew support spaces. Author

**N93-18200#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**TOWARD THE IDEAL MILITARY AVIATION SUNGLASS**
J. S. Marsh (University of West Florida, Pensacola.), W. B. Cushman, and L. A. Temme Nov. 1991 28 p
(AD-A258200; NAMRL-1365) Avail: CASI HC A03/MF A01

Sunglasses and sunvisors affect vision, but can they actually improve it? The effects of sunglasses on vision were modeled considering: (1) Duntley and Middelton's theoretical treatment of the propagation of light through the atmosphere; (2) the dependence of light scatter on wavelength; (3) Blackwell's extensive 'Tiffany' data base describing human visual sensitivity to incremental, contrasting spot stimuli; and (4) human spectral sensitivity. With these factors, sunglass and visor characteristics were identified that maximize the range for detection of small objects. The ideal sunglass or visor thus identified increases the range at which objects can be detected by an average of 5 percent compared to the naked eye. By comparison, the standard 12 filter neutral filter currently used for aviator sunglasses decreases naked eye range by about 5 percent. This paper provides a theoretical framework that could be used in the design and evaluation of sunglasses and visors in environments where vision is critical. GRA

**N93-18293#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**USING CONSTRAINT SATISFACTION NETWORKS TO STUDY AIRCREW SELECTION FOR ADVANCED COCKPITS Interim Report, Oct. 1990 - Jan. 1991**
David J. Blower Jan. 1992 18 p
(NR Proj. MM3-3-P-30)
(AD-A258151; NAMRL-SR92-1) Avail: CASI HC A03/MF A01

Pilot selection techniques for the U.S. Navy must meet the challenges offered by the next generation of aircraft. One specific technological advance is likely to be the introduction of machine intelligence into the cockpit to assist pilots in their assigned tasks. We presently do not have any psychological tests in our selection toolkit to measure the cognitive skills needed to interact optimally with machine intelligence. This research has the goal of developing psychological tests, together with the accompanying mathematical models, to measure individual differences in pilot candidates with regard to cooperative human-machine problem solving. The groundwork for a constraint satisfaction network (CSN) approach to cooperative human-machine problem solving was laid down. The details and terminology of a simple CSN were explained. An algorithm to calculate the minimum energy of a CSN was explored in great depth. This algorithm is important because it is the basis for a numerical solution to the mathematical model underlying the CSN. GRA

**N93-18517*#** Georgia Inst. of Tech., Atlanta. Center for Human-Machine Systems Research.
**COGNITIVE ENGINEERING MODELS IN SPACE SYSTEMS Semiannual Status Report Nos. 3 - 5, 30 Jun. 199 1 - 31 Dec. 1992**
Christine M. Mitchell 15 Dec. 1992 48 p
(Grant NAG9-422)
(NASA-CR-192001; NAS 1.26:192001) Avail: CASI HC A03/MF A01

NASA space systems, including mission operations on the ground and in space, are complex, dynamic, predominantly automated systems in which the human operator is a supervisory controller. The human operator monitors and fine-tunes computer-based control systems and is responsible for ensuring safe and efficient system operation. In such systems, the potential consequences of human mistakes and errors may be very large, and low probability of such events is likely. Thus, models of cognitive functions in complex systems are needed to describe human performance and form the theoretical basis of operator workstation design, including displays, controls, and decision support aids. The operator function model represents normative operator behavior-expected operator activities given current system state. The extension of the theoretical structure of the operator function model and its application to NASA Johnson mission operations and space station applications is discussed. Author

**N93-19039*#** Iowa State Univ. of Science and Technology, Ames. Dept. of Chemical Engineering.

**SPACE LIFE SUPPORT ENGINEERING PROGRAM Semiannual Progress Report, Jul. - Dec. 1991**

Richard C. Seagrave Dec. 1991 4 p

(Grant NAG2-722)

(NASA-CR-192188; NAS 1.26:192188) Avail: CASI HC A01/MF A01

This report covers the first six months of work performed under the NASA University Grant awarded to Iowa State University to perform research on two topics relating to the development of closed-loop long-term life support systems. A comprehensive study to develop software to simulate the dynamic operation of water reclamation systems in long-term closed-loop life support systems is being carried out as part of an overall program for the design of systems for a Mars voyage. This project is being done in parallel with a similar effort in the Department of Chemistry to develop durable accurate low-cost sensors for monitoring of trace chemical and biological species in recycled water supplies. Aspen-Plus software is being used on a group of high-performance workstations to develop the steady state descriptions for a number of existing technologies. Following completion, a dynamic simulation package will be developed for determining the response of such systems to changes in the metabolic needs of the crew and to upsets in system hardware performance. Author

**N93-19104*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**EFFECT OF CONTRAST ON HUMAN SPEED PERCEPTION**

Leland S. Stone and Peter Thompson (York Univ., England ) Dec. 1992 22 p

(RTOP 199-16-12-37)

(NASA-TM-103898; A-91244; NAS 1.15:103898) Avail: CASI HC A03/MF A01

This study is part of an ongoing collaborative research effort between the Life Science and Human Factors Divisions at NASA ARC to measure the accuracy of human motion perception in order to predict potential errors in human perception/performance and to facilitate the design of display systems that minimize the effects of such deficits. The study describes how contrast manipulations can produce significant errors in human speed perception. Specifically, when two simultaneously presented parallel gratings are moving at the same speed within stationary windows, the lower-contrast grating appears to move more slowly. This contrast-induced misperception of relative speed is evident across a wide range of contrasts (2.5-50 percent) and does not appear to saturate (e.g., a 50 percent contrast grating appears slower than a 70 percent contrast grating moving at the same speed). The misperception is large: a 70 percent contrast grating must, on average, be slowed by 35 percent to match a 10 percent contrast grating moving at 2 deg/sec (N = 6). Furthermore, it is largely independent of the absolute contrast level and is a quasilinear function of log contrast ratio. A preliminary parametric study shows that, although spatial frequency has little effect, the relative orientation of the two gratings is important. Finally, the effect depends on the temporal presentation of the stimuli: the effects of contrast on perceived speed appears lessened when the stimuli to be matched are presented sequentially. These data constrain both physiological models of visual cortex and models of human performance. We conclude that viewing conditions that effect contrast, such as fog, may cause significant errors in speed judgments. Author

**N93-19757#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Avionics Panel.

**ADVANCED AIRCRAFT INTERFACES: THE MACHINE SIDE OF THE MAN-MACHINE INTERFACE [LES INTERFACES SUR LES AVIONS DE POINTE: L'ASPECT MACHINE DE L'INTERFACE HOMME-MACHINE]**

Oct. 1992 296 p In ENGLISH and FRENCH Symposium held in Madrid, Spain, 18-22 May 1992

(AGARD-CP-521; ISBN-92-835-0689-8) Copyright Avail: CASI HC A13/MF A03

This Symposium explored the use of three of man's senses (sight, hearing, touch) to improve the man-machine interface in the cockpit. The seven sessions included Defining Concepts and Design Issues, Maintenance for Advanced Cockpit Systems, Panoramic and Virtual Cockpits, Helmet Mounted Displays, Voice Technology, System Design Concepts and Tools, and finally Device Technologies. As the demands placed upon the aircrew by the modern battlefield continue to increase, this Symposium attempted to effectively blend the technologies available to decrease the workload. For individual titles, see N93-19758 through N93-19785.

**N93-19758#** Technische Univ., Twente (Netherlands). Computer Vision Lab.

**ENGINEERING THE VISIBILITY OF SMALL FEATURES ON ELECTRONIC FLIGHT DISPLAYS**

D. Bosman *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 7 p (For primary document see N93-19757 06-54)

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The applications and limitations of high resolution afforded by modern display technologies are discussed, in relation to the properties of the human visual system; and how much 'engineering' may become possible early in the design phase by the use of model(s) of the 'visual system - technology interface' (VSTI). Display technology models provide good predictions of the distributions of luminance, color, and contrast under specified driving and environmental conditions. Coupled to suitable vision models, estimates of visibility of pattern details can be made. In VSTI models, the beholder of the imagery is regarded as a detector responding to displayed pattern with 'yes', 'no', or even be allowed fuzzy and false responses. Some conclusions are given concerning design of pattern details in imagery, given the characteristics of the display and of the observer. Author

**N93-19759#** Naval Air Warfare Center, China Lake, CA. Aircraft Weapons Integration Dept.

**HUMAN FACTORS PROBLEMS FOR AIRCREW-AIRCRAFT INTERFACES: WHERE SHOULD WE FOCUS OUR EFFORTS?**

Judith H. Lind and Carol G. Burge *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 12 p (For primary document see N93-19757 06-54)

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Twenty eight problem areas where human factors engineers lack the information needed for development of crewstations for advanced military fighter and attack aircraft are identified and discussed. Emphasis is on naval air missions projected during the early 21st century against land and sea-surface targets. The 28 problem areas are based on the functions that the crews must carry out for successful mission accomplishment. Human capabilities and limitations documented in the human factors literature that relate to these aircrew functions were used to define the problem areas. The goal is to ensure that aircrew performance will be satisfactory for anticipated air missions. The 28 problem areas are grouped into nine human factors problem categories. For each category, the human factors knowledge and man-machine interface engineering capabilities that should be extended during this decade are noted. The human factors problem categories are (1) physical and physiological stress, (2) vigilance and aircrew alerting, (3) individual differences, (4) information integration, (5) visual displays for various missions, (6) mission management, (7) decision support, (8) automation, and (9) system design and evaluation. Author

**N93-19760#** Telefunken System Technik G.m.b.H., Wedel (Germany). Aircraft Equipment.

**ADVANCED COCKPIT-MISSION AND IMAGE MANAGEMENT**

Juergen Struck, ed. *In* AGARD, Advanced Aircraft Interfaces: The Machine

Side of the Man-Machine Interface Oct. 1992 15 p (For primary document see N93-19757 06-54)
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Modern cockpit designs require new modular architectures for mission and image-management with regards to hardware and software aspects. The main task is the collection of aircraft specific data using the appropriate data management, the transformation of such data to graphical images with the appropriate logical image management, the generation of physical graphical images on several image devices by physical image management and the conversion and combination/mixing of physical graphical data with the data, created by external video sensors using video management. Finally the video-data has to be presented on several devices, like head down-, head up-, and helmet mounted displays. The main goal for us as basic system supplier is to give the application programmer an abstract high-level interface for all these functions. This is to be done and is specially supported by the program language Ada, which is the required language for military and civil aircraft applications. The system described herein was developed for the German experimental helicopter program AVT and two special applications for the X31A experimental aircraft.

Author

**N93-19761#** British Aerospace Aircraft Group, Brough (England). Kingston Military Aircraft Ltd.

**AIRCREW ACCEPTANCE OF AUTOMATION IN THE COCKPIT**

Mark Hicks and Ian Ross (British Aerospace Aircraft Group, Kingston-upon-Thames, England ) *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 5 p (For primary document see N93-19757 06-54)
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The concept of human-electronic co-operation in the cockpit is synonymous with that of a team. Whether or not team members interact effectively will rely largely upon the pilot's acceptance of his electronic team mate. This paper reports on the attitudes of eight British Aerospace test pilots towards the future of such co-operation. Particular emphasis is laid upon the factors of system function, task allocation, and trust. Pilots opinions are examined against a schema of 'Operational Relationships', recently proposed in the literature. Author

**N93-19762#** Rome Lab., Griffiss AFB, NY. Systems Reliability Div.

**TIME STRESS MEASUREMENT DEVICES FOR ENHANCEMENT OF ONBOARD BIT PERFORMANCE**

Leonard J. Popyack, Mark E. McCallum, and James A. Collins *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 6 p (For primary document see N93-19757 06-54)
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An important aspect of a pilots situational awareness is the need for accurate real time information on the operational status of all aircraft systems. False and intermittent indications have been a problem with many of the built-in-test (BIT) functions in aircraft systems. These indications result in Retest OK (RTOK) and Cannot Duplicate (CND) maintenance events when the aircraft returns. These types of events account for 35 percent to 65 percent of the indicated faults in many Air Force avionics systems. Any false indications put an unnecessary and potentially fatal burden on the pilot during the operational scenario and also consume significant maintenance resources. Many of these false alarms and intermittent status indications are related to the environmental conditions present at the time of the indication. Time Stress Measurement Device (TSMD) technology offers a means of providing this crucial environmental information to the system's BIT. TSMD's are digital environmental measurement and recording devices in a microelectronic package which can be embedded into a system at the time of manufacture or on a retrofit basis. The information collected and provided by the TSMD can be provided in real time for the on-board BIT to try and discriminate between transient system performance anomalies and hard failures. Thus, only accurate performance status information is reported to the pilot. The paper describes the background of TSMD development, current state-of-the-art in TSMD hardware and software, current applications which address the enhancement of on-board BIT performance, and future thrusts in the TSMD area. Author

**N93-19763#** Telefunken System Technik G.m.b.H., Ulm (Germany).

**TICAMS: TELEFUNKEN INTEGRATED COMPUTER-AIDED MAINTENANCE SYSTEM** **c61**

Werner Wurster *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 18 p (For primary document see N93-19757 06-54)
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In view of ever decreasing budgets, the Aspect Life Cycle Cost (LCC) of a product is gaining in importance. Telefunken Systemtechnik has been working for more than 10 years in the area of Integrated Logistic Support with the aim of minimizing the LCC for new products. TICAMS is one result of this work. TICAMS is a general test system for development, production, and utilization phases. This universal concept automatically provides the practical and theoretical knowledge of each phase while minimizing costs. In doing so, the overall system requirements with regard to the user are supported by TICAMS thus leading to cost minimization in the utilization phase. TICAMS supports the user in conducting maintenance and repair work, optimizes essential tests and diagnosis procedures during the test procedure, and supports the user during each of the work stages by means of a comprehensive user interface and information system. TICAMS uses test strategies specified to the product which is to be tested and maintained, and works with an expert system for optimizing the diagnosis and test. Author

**N93-19764#** Air Force Wright Research and Development Center, Wright-Patterson AFB, OH. Advanced Technology Integration Office.

**DEVELOPING VIRTUAL COCKPITS**

Wayne L. Martin *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 8 p (For primary document see N93-19757 06-54)
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The motivation for development of virtual crew system technologies stems from the growing complexity of cockpit interfaces and the realization that humans are spatial beings who are much better equipped to process and control information if it bears a spatial and temporal relationship to the way the real world exists at the moment. The virtual cockpit will provide three-dimensioanl (3-D) spherical awareness, intuitive control interfaces, and automated assistance to the pilot. Three-dimensional visual and auditory information will be presented via the pilot's helmet, while tactile information may be presented through micro-stimulators within the pilot's glove, which are activated as a function of hand and/or finger position within the cockpit. The intent is to build a virtual cockpit that creates a representation of the look and feel of the real world, to the extent that the interaction with the display and control of information is as natural as possible. The notion of a virtual cockpit has been popularized in the 'Super Cockpit' concept. The Super Cockpit concept demands a functional integration of a broad range of advanced control, display, and avionic technologies. The successful marriage of the individual capabilities that each of these technologies represent demands an understanding and appreciation of the requirements for sensing, processing, and displaying information to provide the pilot the advantage of 3-D spatial/situational awareness throughout the mission. The multifaceted development issues associated with realization of the virtual cockpit are addressed. Author

**N93-19765#** Wright Research Development Center, Wright-Patterson AFB, OH. Wright Lab.

**PANORAMIC COCKPIT DISPLAYS**

Darrel G. Hopper *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 25 p (For primary document see N93-19757 06-54)
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The great challenge of today's cockpit designers is to provide the 21st century pilot the necessary situation awareness to be effective in combat. This situation awareness is difficult to achieve because a pilot has to look at numerous dials and indicators, multiple small displays with different range scales and ownship locations, and distorted radar images. Today the pilot must fuse all information and be able to make immediate critical decisions in a combat environment. Part of the solution to this information overload problem is a panoramic agile-window display. The advantages of a large area display system were recently demonstrated in the Panoramic Cockpit Control and Display System research program. The principal objective result was a 45 percent increase in pilot combat

effectiveness. The key to the implementation of the panoramic cockpit concept is a large area display together with a helmet-mounted equivalent of the present day head-up display. The large area head down system uses direct view or projected view to create an aggregate display area of 650-2000 sq cm. The status of cockpit displays is reviewed with an emphasis on hardware. Several technologies are being developed simultaneously and are analyzed here against requirements of our cockpit visions for new systems such as the F-22 and RAH-66, retrofit programs like the C-130/C-141, and advanced fighter and transport concepts. Author

**N93-19766#** Dassault-Breguet Aviation, Saint Cloud (France).
**FLIGHT ABOVE A VIRTUAL WORLD [VOL AU-DESSUS D'UN MONDE VIRTUEL]**
P. Larroque and R. Joannes *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 11 p In FRENCH (For primary document see N93-19757 06-54)
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Research for stealth methods of low level penetration flight leads us to consider the use of terrain data bases which are becoming more and more easily available. This is why the French Ministry of Defence has granted DASSAULT AVIATION a contract in the scope of the APIS Exploratory Program. The purpose of this study was to consider the use of terrain files for designing synthetic images intended for combat aircraft. The aim is to provide the pilot with pictures replacing direct sight on the outside world, thus helping him to conduct the flight by any weather or at night. The research for this new concept was supported by intensive software development on real time simulation tools. The latter permitted the proposal of different APIS representations for both head-up and head-level displays. The process followed during the elaboration of the images with the active participation of the French Officials is presented. We also give some examples of proposed pictures. At the end of the study these proposals were assessed by a team of ten military pilots, belonging either to flight test teams or coming from French Navy and Air Force. This evaluation has been carried out by the CERMA (French Aero-Medical Research Institute). However, many points are still to be examined: how to display these pictures onboard while managing safety and limiting costs and resources consumption at an affordable level. Author

**N93-19767#** Delft Hydraulics Lab. (Netherlands). Delft Instruments Electro Optics.
**A NEW CONCEPT FOR HELMET MOUNTED VISION**
G. DeVos, D. M. A. Broekmans, and R. P. Slegtenhorst *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 10 p (For primary document see N93-19757 06-54)
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Successful applications of holographic optical elements (HOE's) in the holographic night vision goggles have led to interesting developments of new concepts for helmet mounted vision systems. The present application of HOE's in night vision goggles is discussed, as well as a new concept of Helmet Mounted Vision Systems. Author

**N93-19768#** Sextant Avionique, Valence (France).
**A VISUAL OF THE HELMET FOR THE PILOTING AND THE DAY/NIGHT NAVIGATION OF THE COMBAT AIRCRAFT: REQUIREMENTS AND TECHNICAL APPROACHES [UN VISUEL DE CASQUE POUR LE PILOTAGE ET LA NAVIGATION JOUR/NUIT DES AERONEFS DE COMBAT: EXIGENCES ET APPROCHE TECHNIQUE]** **c04**
J. P. Cursolle, J. M. Kraus, and Y. Lefort *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 9 p In FRENCH (For primary document see N93-19757 06-54)
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The requirements of piloting and of day as well as night navigation of a combat aircraft force the man-machine interface into permanent evolution. The last fifteen years brought the spread of 'head high' collimators on combat aircraft. However, in spite of holographic techniques which make it possible to increase the size of the optical field presented, research relating to the improvement of the weapons system has been replaced by the creation of a new interface called 'Helmet Sight' placed in front of the eye of the pilot. This interface enables the pilot to point the sensors of the weapons system in a given direction, and, conversely to show an objective to the navigation and armament system. The size of the optical fields proposed for helmet sights, equivalent to the field of a conventional high head sight, remains insufficient to authorize piloting or navigation in full safety. At most, some parameters can be presented to help the pilot in the realization of his mission. With improving techniques, the existence of this type of interface made it possible to present a more complex image in front of the eyes of the pilot. This is called 'Helmet Sight'. A discussion of the requirements of piloting and navigation in all conditions will highlight the essential criteria taken into account for the design of these new sights. Author

**N93-19769#** Royal Aircraft Establishment, Farnborough (England). Flight Systems Dept.
**THE MOD (UK) INTEGRATED HELMET TECHNICAL DEMONSTRATOR PROGRAMME**
A. Karavis and T. H. Southam (Ministry of Defence, London, England ) *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 10 p (For primary document see N93-19757 06-54)
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As a result of progressively adding on capabilities to the basic protective flying helmet, present solutions to operational requirements result in barely acceptable flying helmet assemblies. The devices which provide these capabilities must all be compatible with each other, with the rest of the pilot's Aircrew Equipment Assembly (AEA), and with the aircraft. Often conflicting requirements result in compromises being made. Fundamental rules of optics cannot be changed, and in general, improved optical performance results in larger, heavier head-borne load. Heretofore, the solutions were engineered by several companies, each specializing in a particular discipline, resulting in the present 'add-on' philosophy. The UK MOD has taken the view that the time is appropriate for industry to adopt a more coordinated approach. The Integrated Helmet Technical Demonstrator Program (IHTDP) is aimed at encouraging a helmet to be designed from the outset with wide ranging capabilities, stimulating industry to form consortia to produce a truly integrated helmet. The background to the program and the requirements from the operators' point of view are discussed and the specification of requirements are described. Author

**N93-19770#** Pilkington P.E. Ltd., Saint Asaph (Wales).
**MULTI-FUNCTION VISOR**
J. Foley and A. T. Head *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 3 p (For primary document see N93-19757 06-54)
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A multitude of new roles are required for future aircrew visors. Large numbers of visors on a single helmet is not an acceptable solution. There is therefore a requirement for Multi-Function Visors which perform numerous roles. Many of the optical protective functions carry an unavoidable loss of visual transmittance. When these are combined, the overall visual transmittance may typically be 40 percent or lower. These functions therefore need to be combined on an outer Multi-Function Visor which the pilot can deploy at will. A permanent inner clear visor will provide all the mechanical protection and will also host the HMD combiner. A suite of outer MFV's may be required to cover all the combinations of laser threats in the visible, with the appropriate visor being selected for each mission. Author

**N93-19771#** Istanbul Univ. (Turkey).
**ADVANCES IN SPEECH PROCESSING** **c32**
A. Nejat Ince *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 14 p (For primary document see N93-19757 06-54)
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The field of speech processing is undergoing a rapid growth in terms of both performance and applications and this is fueled by the advances being made in the areas of microelectronics, computation, and algorithm design. The use of voice for civil and military communications is discussed considering advantages and disadvantages including the effects of environmental factors such as acoustic and electrical noise and interference and propagation. The structure of the existing NATO communications network and the evolving Integrated Services Digital Network (ISDN) concept are briefly reviewed to show how they meet the present and future requirements. The paper then deals with the fundamental subject of speech coding and

compression. Recent advances in techniques and algorithms for speech coding now permit high quality voice reproduction at remarkably low bit rates. The subject of speech synthesis is next treated where the principle objective is to produce natural quality synthetic speech from unrestricted text input. Speech recognition where the ultimate objective is to produce a machine which would understand conversational speech with unrestricted vocabulary, from essentially any talker, is discussed. Algorithms for speech recognition can be characterized broadly as pattern recognition approaches and acoustic phonetic approaches. To date, the greatest degree of success in speech recognition has been obtained using pattern recognition paradigms. It is for this reason that the paper is concerned primarily with this technique. Author

**N93-19772#** Lernout and Hauspie Speech Products N.V., Ypres (Belgium).

**THE USE OF VOICE PROCESSING FOR SOME ASPECTS OF THE PILOT-VEHICLE-INTERFACE IN AN AIRCRAFT**

Fernand Hollevoet and Christian J. Wellekens *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 7 p (For primary document see N93-19757 06-54)

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The challenges that lie in the development and design of a pilot vehicle interface (PVI), both in the basic voice processing technologies as in the robustness requirements of the system, due to the peculiar circumstances in which it has to be used, are described. Furthermore, we will focus on the state of the art, and on the results of the current R&D efforts within Lernout and Hauspie Speech Products on both the recognizer itself as well as its robustness, and also the hardware implementation. At the end, we will dip into the future and look at the continuing R&D efforts both to enhance the available algorithms and to undertake new basic efforts in the area of application. Author

**N93-19773#** Sextant Avionique, Valence (France).

**MULTIMODAL DIALOG SYSTEM FOR FUTURE COCKPITS [SYSTEME DE DIALOGUE MULTIMODAL POUR COCKPITS FUTURS]**

J.-N. Perbet, J.-J. Favot, and B. Barbier *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 3 p In FRENCH (For primary document see N93-19757 06-54)

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The display devices of the future will call upon multimedia systems allowing a multimode dialogue between the man and the system. We describe the concept of a large interactive screen, built around an image wall in the instrument panel and an assembly of the means of dialog used simultaneously. It will make it possible to reduce the workload of the pilot by an optimization of the dialogue with the system while using, among other things, an intelligent dialogue assisting device. Many studies have been carried out on the isolated use of input-output devices (keyboard, mouse, handle, vocal reconnaissance...), but none presents a global solution of the multimode dialogue in the cockpit. We thus developed and implemented an experimental device to study man-system interactions using the eye, the hand, and the voice. Author

**N93-19774#** Defence and Civil Inst. of Environmental Medicine, North York (Ontario).

**PRINCIPLES FOR INTEGRATING VOICE I/O IN A COMPLEX INTERFACE**

M. M. Taylor and D. A. Waugh (Andyne Computing Ltd., Kingston, Ontario) *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 14 p (For primary document see N93-19757 06-54)

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The integration of voice into a complex interface like that between a pilot and an aircraft is not trivial. We try to address some of the factors affecting the use and integration of voice in human-machine interfaces. We describe general principles for merging different kinds of human-machine interaction, and apply them to voice interaction in the cockpit. We do this despite published opinion that psychological principles cannot be applied in the design of human-computer interaction. The theory of Layered Protocols (LP) is introduced in context of the more general Perceptual Control Theory of behavior (PCT). LP theory provides a model for describing interaction between complex partners based on a layered structure of protocols that differ in levels of abstraction. The proper use of feedback is fundamental to both LP and PCT. Voice interaction is useful mainly for the control of tasks requiring discrete information. Failure of voice recognition systems is often caused by inappropriate feedback. Providing feedback and forcing correction word by word may increase the mental load on a user, often leading to instability in the interaction. Such inefficient, and often frustrating, use of voice interaction can often be overcome through the use of feedback at higher, more abstract, layers of interaction. Successful adoption of voice interaction depends on allocating the appropriate tasks of communication to the voice protocol, the dynamic modeling of the partner, and the use of higher level protocols to help control potential instability. Author

**N93-19775#** Sextant Avionique, Valence (France).

**G-LOAD EFFECTS AND EFFICIENT ACOUSTIC PARAMETERS FOR ROBUST SPEAKER RECOGNITION**

Ch. Gulli, D. Pastor, A. Leger, P. B. Sandor, J. M. Clere (Centre d'Essais en Vol, Bretigny-Air, France ), and P. Grateau (Centre d'Essais en Vol, Bretigny-Air, France ) *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 14 p (For primary document see N93-19757 06-54)

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Acoustic features of the speech production with G-load effects were found from the computer signal analysis. Their correlates with physiological features will permit an interpretation of the variability of formant and pitch shifts. The pilot study experiments were conducted by SEXTANT and the LAMAS (Laboratoire de Medecine aerospatiale). Six subjects participated in the experiment. Their mean age was 30 years. A series of experiments in centrifuge environment were performed as part of a research program. A specific vocabulary was made for the first investigation with speakers in centrifuge. Comparison of spectrographic analysis and wavelet decomposition have permitted to show a spectral pattern modification for recognition process. Due to the accuracy and limitations of the sonograph measurements, we developed multiresolution transforms. A window Fourier transform is better suited for analyzing signals where all patterns appear approximately at the same scale. The old multivariate statistical analysis, after the Bark's transformation, can produce a good projection on the eigenvectors of the correlation matrix. The choice of the eigenvalues seems very easy for seeking the best representation of speech production. An interpretation of the mechanical effects due to the acceleration can be shown with analysis tools. We observed, in agreement with acoustic multi-resolution analyses, that producing speech in G-load conditions can increase energy, pitch, and formant frequency locations. The influence of the breathing on some parameters is noticeable. The last section discusses the incidence of these results on the robust speech recognizer for military cockpit environment. Author

**N93-19776#** Naval Air Warfare Center, China Lake, CA. Weapons Div.

**A SYSTEMS APPROACH TO THE ADVANCED AIRCRAFT MAN-MACHINE INTERFACE**

F. Armogida *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 13 p (For primary document see N93-19757 06-54)

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Current thinking on the aircraft man-machine interface focuses primarily on the cockpit. My proposed approach will view the mission planning/mission rehearsal and the aircraft as an integral system that can perform three functions: (1) dynamically adjust itself to the particular pilot response in the planning/rehearsal stage, (2) adjust itself during the strike based upon the scenario encountered, and (3) adjust itself after each mission to enhance planning for follow-on missions. The objectives are to improve strike effectiveness and to shift portions of the pilot's work load from the attack to the planning phase of the strike. This concept can be implemented using existing and emergent technologies. Aircraft now coming on line are equipped with removable disks that are used to load mission specific data for the avionics and weapon systems (maps, ELINT files, route plans, navigation data, target coordinates, etc.). Mission planning systems are being configured not only to provide these data, but also to evaluate post flight data from flight recorders. Mission planning and rehearsal with the resulting aircraft mission data package will provide more inputs for the aircraft mission computer that will eventually fly the mission. Inter-aircraft computer communications will support adaptively optimizing the strike based upon the threat and target conditions encountered and the success of the strike to that point in time (adaptive mission control). Pilot intervention may

only be required for aircraft-to-aircraft combat, freeing the pilot to attend to weapon aimpoint selection tasks (where the automatic systems have low confidence in their selections) or for unplanned contingencies. The mission planning/aircraft system, the notional aircraft avionics for adaptive mission control, and the implications for the man-machine interface are described. Author

**N93-19777#** Royal Air Force, Farnborough (England). Mission Management Aid Project.

**MANAGEMENT OF AVIONICS DATA IN THE COCKPIT**

E. J. Lovesey *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 5 p (For primary document see N93-19757 06-54)

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The rapid developments in avionics and the associated processing power now available in aircraft have produced cockpit systems which can quickly saturate the crew with information. Only by understanding man's capabilities and limitations will it be possible to design integrated avionics systems which match man's requirements and result in an effective man-machine combination. Only by paying great attention to management of the information flow between aircrew and avionics systems will it be possible to optimize the man-machine system in future combat aircraft. Examples of past problems and current developments in the management of data flow in the cockpit are given. Author

**N93-19778#** Smiths Industries Ltd., Bishops Cleeve (England).

**MODEL-BASED REASONING APPLIED TO COCKPIT WARNING SYSTEMS**

C. R. Ovenden *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 7 p (For primary document see N93-19757 06-54)

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With the advances in display technology and the increasing use of software control, more information in the modern commercial aircraft cockpit is available on request only instead of continually. Furthermore, the reduction in crew size has resulted in a reduction in the routine monitoring of system parameters. However, advances in sensory capability are enabling far more system parameters to be measured. The combination of these trends leads to the perception by the aircrew of an abrupt transition from normal operation to the need to deal with system malfunction. Work undertaken to maximize the use of available information in order to maintain the aircrew's awareness of the status of the aircraft's systems and to provide advice in the advent of malfunction or abnormality is outlined. The appropriate carrier of such information is the modern centralized cockpit warning systems. Author

**N93-19779#** British Aerospace Aircraft Group, Preston (England). Military Aircraft Div.

**THE INTEGRATION OF ADVANCED COCKPIT AND SYSTEMS DESIGN**

P. R. Wilkinson *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 9 p (For primary document see N93-19757 06-54)

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The way in which typical operational scenarios that are representative of future conflict impact on the specification and design for man/machine performance is examined. Operational Requirements for aircraft to survive and deliver the goods in this context present a tremendous challenge to the Prime Weapon System Contractor. Military procurement agencies have long been striving to realize increased weapon system performance from dwindling resources. Thus current initiatives such as MANPRINT have been launched to change an equipment-oriented view of system development towards a broader view that considers hardware, software, and operator together as a system. It is argued that unless the piloting function and system integration tasks are considered as an integral part of the design process from day one, a less than optimum design will always result. It is recommended that a structured top-down design methodology be employed that translates Operational Requirements into piloting and system functions at one and the same time. An overview is given of use of just such a design process developed at BAe Warton, with particular reference to the European Fighter Aircraft (EFA) project. The various stages of the design process are explained and indications given of current progress of EFA. Emphasis is given to the tools and methods used to ensure that a highly integrated system and advanced cockpit design are successfully achieved. Author

**N93-19780#** Elektronik-System G.m.b.H., Munich (Germany).

**CVA, COCKPIT DESIGN AND DEVELOPMENT TOOL**

Christoph Weber *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 5 p (For primary document see N93-19757 06-54)

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The conceptual design and development of a modern helicopter cockpit requires the consideration of ergonomic, operational, and technical aspects. New and additional technologies lead to a steady increase of data and workload, so that an essential task is to obtain an optimum layout of the 'Man-Machine-Interface' (MMI). For the performance of this task, MoD has charged ESG to generate a national Cockpit Design Tool CVA and to operate it in parallel with the TIGER development. Due to the national character of the CVA those tasks are primarily handled which concern the specific German portion of the TIGER program, e.g. the control and display system of the digital map generator, the helmet-mounted sight/display system, and the HF data link. These complex systems, however, cannot be investigated separately due to the multiple reciprocal actions with the remaining display and control systems, but have to be considered with the overall cockpit. Thus the CVA is the reproduction of a functioning 1:1 cockpit of the PAH2 version of the TIGER and is operated in close cooperation with the future user (pilot). It is a closed-loop simulator which enables the checking of important areas of the MMI not only in theory, but mainly under practical conditions long before a prototype of the new helicopter exists. Author

**N93-19781#** Naval Air Warfare Center, China Lake, CA. Aircraft Weapons Integration Dept.

**MAN-MACHINE INTERFACE WITH SIMULATED AUTOMATIC TARGET RECOGNITION SYSTEMS**

Marion P. Kibbe and Edward D. McDowell *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 10 p (For primary document see N93-19757 06-54)

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Growing numbers of targeting information sources in military cockpits have led to the development of automatic target recognition (ATR) systems. Since initially most ATR's will be used with an operator, a series of experiments was conducted to investigate aspects of the interface between the operator and the ATR. Two experiments are described which measured the speed and accuracy of ship identifications made by an operator using information from an imaging sensor and a simulated ATR. These measures were compared to performance of the unaided operator and to performance of the autonomous ATR. The accuracy of the ATR, the format of its output, and the quality and type of the sensor information was varied in the experiments. The results are discussed in terms of their implications for the design of the operator-ATR interface that will lead to satisfactory system performance. Author

**N93-19782#** Litton Systems (Canada) Ltd., Rexdale (Ontario).

**THE ACTIVE-MATRIX LC HEAD-DOWN DISPLAY (AM-LCD): OPERATIONAL EXPERIENCE AND GROWTH POTENTIAL**

J. F. Farrell, J. C. Prince, and J. C. Wright *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 11 p (For primary document see N93-19757 06-54)

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After a protracted development period, the active-matrix addressed liquid crystal light valve is finding increasing employment in a variety of head-down primary flight instrument applications. While the packaging efficiencies of such a flat panel technology are self-evident, many of its other attributes are also likely to have a profound impact upon crew station design. In order to successfully exploit the positive aspects of this technology, it is appropriate that the avionics systems architects benefit from the, albeit limited, current operational data base and develop a realistic understanding as to the limits and rate of advancement pertinent to this class of display device. The following paper is offered as an element in this information dissemination process from a source that has maintained a presence in the technology since 1984 and has participated in active-matrix liquid crystal display (AM-LCD) solutions for such diverse air-vechicle requirements as YF-23, LH, P-3C, and C-130. Author

**N93-19783#** Sextant Avionique, Saint Medard en Jalles (France).
**LIQUID CRYSTAL DISPLAYS REPLACING THE CRT AND CLE OF FUTURE COCKPITS [LES ECRANS A CRISTAUX LIQUIDES REMPLACANT DU CRT ET CLE DES FUTURS COCKPITS]** **c06**
Frederic deLauzun *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 9 p In FRENCH (For primary document see N93-19757 06-54)
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Due to well-known advantages such as low weight, reduced volume, low consumption, visibility (under high brightness) reliability, to mention the most important, the flat panels have already started to replace the CRT in the world of military aircraft. Among flat panels, the liquid crystal active matrix display is the most advanced. Full colors and grey shades displays are mass produced for commercial applications and new military cockpits, both for airplanes and helicopters based on that technology (Rafale is used as an example to illustrate the advantages of LCD compared to CRT). Furthermore, liquid crystal panel is a technical key which will help future cockpit concepts to wake-up to life. The head level display and the large interactive display are among them. Projection techniques and liquid crystal cells are merged to take benefits of liquid crystal, removing the drawbacks (that notion is illustrated by a brief description of a head level display demonstrator). Author

**N93-19784#** Naval Air Warfare Center, China Lake, CA. Weapons Div.
**ADAPTIVE AUTONOMOUS TARGET CUER**
Chi-Kin Lam, Daniel Searle, and Wayne Tanaka *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 8 p (For primary document see N93-19757 06-54)
Copyright Avail: CASI HC A02/MF A03

The Navy is exploring the use of an adaptive autonomous target cuer that is potentially more reliable than existing systems. Variations in the operational environment and target type are major factors that can degrade an autonomous sensor-based cuer performance. The solution presented here is to have several parallel algorithms for each functional component in our target cuer. Each algorithm is tuned to handle a particular situation. Based on certain indicator functions, a fuzzy logic expert system controller will select the most suitable algorithm and optimal parameters to process the sensor data. Although the proposed system is essentially comprised of conventional components such as image preprocessing, feature extraction, and correlation, it distinguishes itself because of its use of fuzzy logic in decision making and its adaptive nature. In designing an expert system, we will select the optimal set of indicator functions using the Taguchi process-control methodology. Preliminary results will be presented. Author

**N93-19785#** Eurocopter Deutschland G.m.b.H., Munich (Germany).
**EQUIPMENT, MORE OR LESS READY TO BE USED IN HELICOPTERS**
H. Hellmuth and H.-D. V. Boehm *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 6 p (For primary document see N93-19757 06-54)
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Examples of equipment taken from project studies and the specific boundary conditions for helicopters are discussed. Avionic equipment, sensors, displays, and controls are covered. Equipment and technologies ready to be used today and in the near future as well as equipment hardly usable are analyzed. Equipment specific characteristics and helicopter/cockpit integration specifics are covered. Author

**N93-19955#** Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
**VENTILATION LOSS IN THE NASA SPACE SHUTTLE CREW PROTECTIVE GARMENTS: POTENTIAL FOR HEAT STRESS Final Report**
Gregory K. Askew and Jonathan W. Kaufman 31 Dec. 1991 20 p (AD-A258552; NADC-91129-60) Avail: CASI HC A03/MF A01

The potential of the National Aeronautics and Space Administration (NASA) S1035 Launch/Entry suit (LES) for producing heat stress in a simulated Space Shuttle cabin environment has been studied. The testing was designed to determine if the NASA S1035 poses a greater threat of inducing heat stress than the NASA S1032. Conditions were designed to simulate an extreme prelaunch situation, with chamber temperatures maintained at dry bulb temperature 27.2 +/- 0.1 C, globe temperature - 27.3 +/- 0.1 C, and wet bulb temperature 21.1 +/- 0.3 C. Four males, aged 28-48, were employed in this study, with three subjects having exposures in all four conditions and the fourth subject exposed to 3 conditions. Test durations in the ventilated (V) and unventilated (UV) conditions were designed for 480 minutes, which all subjects achieved. No significant differences related to experimental conditions were noted in rectal temperatures, heart rates or sweat rates. The results indicate that the S1032 and S1035 garments, in either the V or UV state, poses no danger of inducing unacceptable heat stress under the conditions expected within the Shuttle cabin during launch or re-entry. GRA

**N93-19464*#** North Carolina Agricultural and Technical State Univ., Greensboro. Human-Machine Systems Engineering Lab.
**MODELING HUMAN RESPONSE ERRORS IN SYNTHETIC FLIGHT SIMULATOR DOMAIN**
Celestine A. Ntuen *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 12 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

**N93-19465*#** North Carolina Agricultural and Technical State Univ., Greensboro. Human-Machine Systems Engineering Lab.
**MODELING THE PERFORMANCE OF THE HUMAN (PILOT) INTERACTION IN A SYNTHETIC FLIGHT DOMAIN: INFORMATION THEORETIC APPROACH**
Celestine A. Ntuen *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 12 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

**N93-19466*#** North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Electrical Engineering.
**RECOGNITION OF PARTIALLY OCCLUDED THREAT OBJECTS USING THE ANNEALED HOPEFIELD NETWORK**
Jung H. Kim, Sung H. Yoon, Eui H. Park, and Celestine A. Ntuen *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 10 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

**N93-19662#** H. W. Structures Ltd., Pitsea (England).
**OCCUPANT KINEMATICS SIMULATION OF THE KEGWORTH AIR ACCIDENT**
R. Haidar and N. Rock *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)
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**N93-19665#** Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands). TNO Crash-Safety Research Centre.
**OCCUPANT SIMULATION AS AN ASPECT OF FLIGHT SAFETY RESEARCH**
J. J. Nieboer, J. Wismans, and R. Verschut *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 9 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19666#** Arup (Ove) and Partners, London (England).
**COMPUTER AIDED METHODS FOR SIMULATING OCCUPANT RESPONSE TO IMPACT USING OASYS DYNA3D**
T. J. Keer, R. M. V. Sturt, and B. D. Walker *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 16 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A03/MF A04

**N93-19667#** Applied Physics, Inc., Nanuet, NY.
**DESIGN/DEVELOPMENT OF AN ENHANCED BIODYNAMIC MANIKIN**
Paul H. Frisch and William Boulay *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 9 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19668#** Simula, Inc., Phoenix, AZ.
**IMPROVING MANIKIN BIOFIDELITY**
Caroline VanIngen-Dunn, Marvin Richards, and Ints Kaleps (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 14 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A03/MF A04

**N93-19669#** Department of Transport (England). Transport Research Lab.
**THE DESIGN AND USE OF AUTOMOTIVE CRASH TEST DUMMIES**
A. K. Roberts *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19670#** Biokinetics and Associates Ltd., Ottawa (Ontario).
**AN IMPROVED ANTHROPOMETRIC TEST DEVICE**
Tom Gibson, James Newman, John W. Zellner (Dynamic Research, Inc., Torrance, CA.), and Kenneth D. Wiley (Dynamic Research, Inc., Torrance, CA.) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 7 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19671#** Royal Netherlands Air Force, Volkel. Inst. of Aviation Medicine.
**THE APPLICATION OF HYBRID 3 DUMMY TO THE IMPACT ASSESSMENT OF A FREE-FALL LIFEBOAT**
D. H. Glaister, P. J. Waugh, and L. Neil *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19672#** New Orleans Univ., LA. Naval Biodynamics Lab.
**A NEW INSTRUMENTATION SYSTEM FOR MEASURING THE DYNAMIC RESPONSE OF THE HUMAN HEAD/NECK DURING IMPACT ACCELERATION**
M. S. Weiss, G. C. Willems, S. J. Guccione, Jr., C. J. Mugnier, and M. E. Pittman *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 6 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19699#** Spanish Air Force, Talavera AFB. Flight Surgeon.
**AN EPIDEMIOLOGICAL STUDY IN SAF'S PILOTS EJECTIONS**
J. L. Garcia Alcon, M. R. Duran Tejeda (Extremadura Univ., Badajoz, Spain), and J. M. Moreno Vazquez (Extremadura Univ., Badajoz. Spain) *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 8 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A02/MF A04

**N93-19704#** Institute of Aviation Medicine, Oslo (Norway).
**THE NEXT GENERATION FEMALE IN COCKPIT: DO WE NEED A NEW APPROACH TO COCKPIT RESOURCE MANAGEMENT (CRM)?**
G. Myhre and J. E. Jansen *In* AGARD, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques Sep. 1992 3 p (For primary document see N93-19653 06-03)
Copyright Avail: CASI HC A01/MF A04

**N93-19917#** Aeroplane and Armament Experimental Establishment, Boscombe Down (England).
**HELICOPTER NIGHT VISION GOGGLE TESTING IN THE UNITED KINGDOM**
Michael R. Swales and Randall W. Cason *In* AGARD, Flight Testing Oct. 1992 12 p (For primary document see N93-19901 06-05)
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## 55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

## 59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

**N93-17829#** Amsterdam Univ. (Netherlands). Dept. of Philosophy.
**THE KINEMATICS OF PRESUPPOSITION**
David I. Beaver (Edison, Thomas A. Industries, Bloomfield, NJ ) Apr. 1992 34 p
(LP-92-05; ETN-93-93106) Avail: CASI HC A03/MF A01

The problems of presupposition are addressed under three groups: the projection of presuppositions from truth functionality connected compounds, the behavior of presuppositions in quantificational contexts, and the accommodation of presupposed information. These three topics are studied, each study starting with an empirically oriented subsection concerning the chief problem(s) to be addressed and followed by further study containing the mixture of technicality and speculation that constitutes the theory. The links between existing context change models of presupposition and Veltman's update semantics are addressed. The interaction between presupposition, quantification and anaphora are addressed. The modeling of 'global accommodation' within a CCP (Context Gauge Potential) model account is shown. A comparison with some other types account is given.
ESA

## 60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

**N93-18348#** Wright Lab., Eglin AFB, FL.
**ARCHITECTURE/ENVIRONMENT EVALUATION Final Report, Jun. 1989 - Feb. 1992**
George York Oct. 1992 51 p
(AD-A257849; WL-TR-92-7015) Avail: CASI HC A04/MF A01

The objective of the Architecture/Environment Evaluation project was to determine the ideal microprocessor and the Ada software environment for embedded guidance, navigation, and control processing for tactical missiles. Off-the-shelf microprocessors and compilers were evaluated using the Optimum Guidance Law Implementation (OGLI) benchmarks. The processors included the MIPS R3000, Sun SPARC, Motorola 88000, IBM System/6000, TI TMS320C30, INMOS transputer T800, Intel 80386, and the DEC MicroVAX 11. This research also included an experiment implementing OGLI on a parallel computer (transputer) to improve performance.
GRA

**N93-18516*#** Rensselaer Polytechnic Inst., Troy, NY. Electrical, Computer, and Systems Engineering Dept.
**A PROPOSAL OF AN ARCHITECTURE FOR THE COORDINATION LEVEL OF INTELLIGENT MACHINES**
Randall Beard, Jeff Farah, and Pedro Lima 21 Jan. 1993 35 p
(Grant NAGw-1333)
(NASA-CR-191990; NAS 1.26:191990; CIRSSE-133) Avail: CASI HC A03/MF A01

The issue of obtaining a practical, structured, and detailed description of an architecture for the Coordination Level of Center for Intelligent Robotic Systems for Sapce Exploration (CIRSSE) Testbed Intelligent Controller is addressed. Previous theoretical and implementation works were the departure point for the discussion. The document is organized as follows: after this introductory section, section 2 summarizes the overall view of the Intelligent Machine (IM) as a control system, proposing a performance

measure on which to base its design. Section 3 addresses with some detail implementation issues. An hierarchic petri-net with feedback-based learning capabilities is proposed. Finally, section 4 is an attempt to address the feedback problem. Feedback is used for two functions: error recovery and reinforcement learning of the correct translations for the petri-net transitions. Author

**N93-18891#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A USER INTERFACE TO A TRUE 3-D DISPLAY DEVICE M.S. Thesis**

Bruce A. Hobbs Dec. 1992 74 p

(AD-A258995; AFIT/GCE/ENG/92D-06) Avail: CASI HC A04/MF A01

This thesis describes an interactive interface to a true three dimensional, real-time dynamic graphic display, the TI Omniview. The system generates true 3-D images of volumetric data and objects. The TI Omniview is a cylindrical volumetric laser display that uses a rotating double-helix translucent disk to fill the display cylinder. Voxels are illuminated on the 2-D surface. The rotational speed of the disk allows the viewer to fuse the 2-D images into a true 3-D image. The interface provides the user with a quick and flexible means of manipulating the image generated, the sub-volume displayed, and the resulting 3-D image. The interface provides the user with the flexibility and convenience that a window, icon, mouse, and pointer graphical user interface provides to users of 2-D displays. Limitations of the device, however, do not allow the use of icons and pointers in the Omniview display. Instead, a combination of voice commands, a joystick, and a 2-D menu system running on a host computer is used to provide the interface. This interface allows the user to select objects and scenes, but does not allow manipulation, such as rotation or placement, of individual objects. GRA

**N93-19347*#** Rensselaer Polytechnic Inst., Troy, NY. Center for Intelligent Robotic Systems for Space Exploration.

**A COMPUTER ARCHITECTURE FOR INTELLIGENT MACHINES**

D. R. Lefebvre and G. N. Saridis Dec. 1991 19 p

(Grant NAGw-1333)

(NASA-CR-191861; NAS 1.26:191861; CIRSSE-108) Avail: CASI HC A03/MF A01

The Theory of Intelligent Machines proposes a hierarchical organization for the functions of an autonomous robot based on the Principle of Increasing Precision With Decreasing Intelligence. An analytic formulation of this theory using information-theoretic measures of uncertainty for each level of the intelligent machine has been developed in recent years. A computer architecture that implements the lower two levels of the intelligent machine is presented. The architecture supports an event-driven programming paradigm that is independent of the underlying computer architecture and operating system. Details of Execution Level controllers for motion and vision systems are addressed, as well as the Petri net transducer software used to implement Coordination Level functions. Extensions to UNIX and VxWorks operating systems which enable the development of a heterogeneous, distributed application are described. A case study illustrates how this computer architecture integrates real-time and higher-level control of manipulator and vision systems. Author

**N93-18841*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**CSI FLIGHT COMPUTER SYSTEM AND EXPERIMENTAL TEST RESULTS**

Dean W. Sparks, Jr., F. Peri, Jr., and P. Schuler *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 317-341 (For primary document see N93-18818 06-18) Avail: CASI HC A03/MF A04

# 61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

**N93-17818#** Naval Postgraduate School, Monterey, CA.

**THE DESIGN AND IMPLEMENTATION OF A USER INTERFACE FOR THE COMPUTER-AIDED PROTOTYPING SYSTEM M.S. Thesis**

Robert M. Dixon 24 Sep. 1992 289 p

(AD-A258017) Avail: CASI HC A13/MF A03

The Computer Aided Prototyping System (CAPS) is a software tool intended to make the software development cycle more efficient. Through the use of prototyping, the functional requirements for an embedded system can be quickly validated before wasting resources on an inadequate design. As CAPS is composed of separate tools, the user interface must tie these separate programs together into one coherent tool easily used by a software engineer. This thesis discusses the design and implementation considerations involved in creating an improved user interface for CAPS. The new interface is simpler for the user to use and configure. It is also easier for the system administrator to make changes as tools are added to the system and improved. The new interface also tightly couples the Prototype System Description Language (PSDL) syntax-directed editor to the graph editor, and enables automatic propagation of constraints between the two. The final design is presented, along with the implementation. The thesis also contains a manual for using the system as well as a programmer's manual. GRA

**N93-17823#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**A CONCEPT STUDY FOR A NATIONAL SOFTWARE ENGINEERING DATABASE Final Report**

Patricia B. VanVerth Jul. 1992 71 p

(Contract F19628-90-C-0003)

(AD-A258254; CMU/SEI-92-TR-23; ESC-TR-92-023) Avail: CASI HC A04/MF A01

Substantial segments of the software engineering community perceive a need for high-quality software engineering data at a national level. A national software engineering database has been proposed as one way to satisfy this need. But is such a database feasible and can it really satisfy these needs? This report provides information obtained from an informal survey of members of the software engineering community about a national database. The survey served as a means of getting a sense of the expectations that are to be met by building a national database, and provided the opportunity to learn from the experiences of those surveyed about data collection and use. The report summarizes this material in a manner that is informative and expository rather than prescriptive. GRA

**N93-17827#** Amsterdam Univ. (Netherlands). Dept. of Philosophy.

**THE SEMANTICS OF PLURAL NOUN PHRASES**

Henk Verkuyl (Utrecht State Univ., Netherlands ) and Jaap vanderDoes Oct. 1991 43 p

(LP-91-07; ETN-93-93099) Avail: CASI HC A03/MF A01

Two approaches to plural Noun Phrases (NP's) are reviewed. The aim is to show that their analysis of sentences such as the following can be improved upon: (1) two girls ate five sandwiches; (2) all boys crossed the street. Disregarding the issues of scope ambiguity, a matter quite separate from finding a proper semantics for plural NP's and thus ignored whenever possible, both Scha and Link attach different readings to (1): Scha nine, and Link four. In contrast, the semantics proposed takes it to be unambiguous. A collective and distributive reading is talked of, but only as a conceptually handy way to distinguish between two types of situation which, among other types, may verify sentence (1). (1) is considered vague as to being collective, distributive or otherwise. Scha and Link are discussed, and a semantics for plural NPs characterized by the following properties is presented: sentences get a unique meaning in a compositional way in which the subject NP has the object NP within its scope; the semantics works for arbitrary NP's; all NP's are of the same type and no NP is structurally ambiguous between a distributive and a collective reading;

restriction is made to NP's containing count nouns, allowing standard type logical techniques rather than using an algebraic semantics along the lines of Link. ESA

**N93-17830#** Amsterdam Univ. (Netherlands). Dept. of Philosophy.
**A NOTE ON INTERROGATIVES AND ADVERBS OF QUANTIFICATION**
Jeroen Groenedijk and Martin Stokhof Jul. 1992 30 p Submitted for publication Sponsored by EEC
(LP-92-07; ETN-93-93107) Avail: CASI HC A03/MF A01

A topic in the semantics of interrogatives is addressed. An informal sketch of the basics of a semantics for interrogatives within a classical intensional framework is given. A number of assumptions which figure in the background are described. An indication as to how such an analysis can be implemented is given. The difference between the weak exhaustiveness view and the strong exhaustiveness view is investigated. The challenge made by Berman is addressed and a demonstration of how the analysis can be made to meet Bermans challenge is given. Attention is drawn to a fundamental difference between the approach presented and Berman's way of dealing with quantificational variability. A remark is made as to the fact that in the analysis proposed, a crucial feature of Berman's analysis, that the wh- terms are to be treated in the same way as indefinites, plays no role. The conclusions drawn from the observations is that although it may be appealing at first sight to treat wh- terms in the same way as indefinites in order to account for quantification variability, in fact this hypothesis seems unwarranted. As indicated in an example, they can be treated either as restricted lambda abstraction, or in terms of dynamic existential quantification, or in terms of universal quantification. It does not really matter. As long as interrogatives are assigned a strongly exhaustive interpretation, quantificational variability can be accounted for in any of these three alternatives. ESA

**N93-17831#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**A SYSTEM OF DYNAMIC MODAL LOGIC**
Maarten deRijke Jul. 1992 33 p Sponsored by Netherlands Foundation for Philosophical Research
(LP-92-08; ETN-93-93108) Avail: CASI HC A03/MF A01

A study addressing the need to make statements, not only about cognitive states, but also about transitions between such states in certain areas of logic dealing with information, is presented. A model logic designed for this purpose is analyzed. On top of an abstract informational ordering on states it has instructions to move forward or backward along this ordering, to states where a certain assertion holds or fails, while also allowing the combination of such instructions by means of the standard operations from relational algebra. In addition, the logic has devices for expressing whether or not in a given state a certain instruction can be carried out, and whether or not that state can be arrived at by carrying out a certain instruction. The technical aspects of this dynamic modal language are addressed. A precise description of the expressive power of this language and results on decidability for the language with 'arbitrary' structures and for the special case with a restricted class of admissible structures are given. A complete axiomatization of the validities over arbitrary structures as well as of the validities over this restricted class of structures is given. A remark about modal algebras appropriate for the language studied, plus some speculations and suggestions for further work, are given. ESA

**N93-17833#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**ALTERNATIVE OPTIMIZATION STRATEGIES FOR LARGE-SCALE PRODUCTION-ALLOCATION PROBLEMS**
F. A. Lootsma 1992 49 p
(Rept-92-13; ETN-93-93110) Copyright Avail: CASI HC A03/MF A01

Modeling projects carried out in a large multinational product division to support reallocation of production in factories are addressed. Many optimization problems arising in practice are so complicated that current tools for optimization do not supply a single, clean answer. A variety of optimization methods, has had to be applied. Using a production allocation problem as a vehicle for communication, several near optimal solutions are generated via decomposition, piecewise linear programming, and mixed integer programming. Multicriteria analysis is then shown to be usable to select one of the resulting allocation patterns for implementation in practice. Thus, instead of the problem with a continuum of alternatives, a finite number of alternatives under several conflicting performance criteria is eventually considered. The study particularly illustrated the significance of mathematical modeling in the power game between globally operating product divisions and locally operating national organizations. ESA

**N93-17834#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and informatics.
**AN INTERIOR POINT APPROACH TO POSTOPTIMAL AND PARAMETRIC ANALYSIS IN LINEAR PROGRAMMING**
B. Jansen, C. Roos, and T. Terlaky Apr. 1992 33 p
(Rept-92-21; ETN-93-93115) Copyright Avail: CASI HC A03/MF A01

Problems in the simplex based approach to understanding the solution behavior of the linear programming problem are discussed and proposals are made to resolve the difficulties. Postoptimal analysis in linear programming is analyzed from an interior point of view. Use is made of the partition of the variables induced by a pair of strictly complementary solutions; this partition will be called the optimal partition and is unique. It is well known that many interior point methods generate such a pair of solutions in the interiors of the optimal faces. Changes in a single coefficient of the right hand side or the objective function are considered. The corresponding optimal value functions are known to be piecewise linear functions. The ranges where these functions change linearly are shown to be exactly the intervals where the optimal partition does not change. Examples are given to compare the information obtained from both the classical approach and the given approach. Results can straightforwardly be extended to parametric linear programming. ESA

**N93-17836#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.
**SUB-GROUPS OF Z(SUP n), STANDARD BASIS, AND LINEAR DIOPHANTINE SYSTEMS**
Loic Pottier Sep. 1991 12 p
(INRIA-RR-1510; ETN-93-93368) Avail: CASI HC A03/MF A01

The characterization of a (affine) subgroup of Z(sup n) by a polynomial ideal and standard (Groebner) basis is presented. The use of this standard basis to directly solve many algorithmic problems on (affine) subgroups and their nonnegative parts is shown: the membership problem; the trivality problem; find the smallest non zero vector; find the minimal non-negative elements; solve linear diophantine systems (Ax = 0, x greater than or equal to 0), (Ax = b, x greater than or equal to 0), Ax less than or equal to b on integers, and find smallest solutions. Other properties of thier standard basis are conjectured. ESA

**N93-17838#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.
**AUTOMATIC ANALYSIS AND TRANSFORMATION OF FORTRAN PROGRAMS USING A TYPED FUNCTIONAL LANGUAGE**
Nicole Rostaing (Nice Univ., France ) and Stephane Dalmas (Centre National d'Etudes Spatiales, Toulouse, France ) Sep. 1991 12 p
(INRIA-RR-1518; ETN-93-93370) Avail: CASI HC A03/MF A01

A study addressing the symbolic manipulation of mathematical objects represented as FORTRAN programs is presented. The approach is based on the use of a polymorphic functional language, CAML. The advantages of this choice and the construction of the first components of what will be a toolkit for program analysis and transformation are explained. Two examples of applications are presented: the first relating to totally algorithmic code transformations; the second concerning transformations where the human experience seems indispensable. The study provides an opportunity to apply some symbolic computation tools to numerical computation. ESA

**N93-17841#** Amsterdam Univ. (Netherlands). Dept. of Philosophy.
**AN UPDATE SEMANTICS FOR DYNAMIC PREDICATE LOGIC**
Paul Dekker Apr. 1992 24 p Submitted for publication
(LP-92-04; ETN-93-93105) Avail: CASI HC A03/MF A01

An update semantics for Groenendijk and Stokhof's dynamic predicate logic is proposed. In the proposed system, sentences are interpreted as (partial) update functions on a domain of information states which are sets of partial variable assignments. The introduction of quantification (symmetric

and asymmetric) and generalized quantifiers in a perspicuous and uniform way is demonstrated. ESA

**N93-17846#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**A TESTBED FOR FLOW VISUALIZATION RESEARCH**

Andrea J. S. Hin, Frits H. Post, and Theo vanWalsum 1992 15 p

(Rept-92-32; ETN-93-93124) Copyright Avail: CASI HC A03/MF A01

A testbed approach for research in computer graphics for flow visualization is described. In visualization research, a good environment for development, testing, and integration of results is required. A research testbed is such an environment, as opposed to a visualization system that is to be used as a tool by prospective users. The requirements for a testbed for flow visualization research are outlined, and a logical pipeline model of the visualization process is used to describe a basic design of a flow visualization testbed. A partial implementation is described, and some issues concerning further development are discussed. ESA

**N93-17848#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**PARALLEL CONTRACTION OF BINARY DAGS**

J. P. M. deVreught 1992 26 p

(Rept-92-36; ETN-93-93128) Copyright Avail: CASI HC A03/MF A01

A generalization of tree contraction algorithms that works for ordered binary dags is described. These algorithms make use of several well known techniques like Brent's scheduling, finding a Euler tour, and list ranking. A class of dags is characterized for which the dag contractor algorithm runs in polylogarithmic time with a polynomial number of processors. ESA

**N93-17863#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.

**DEVELOPMENT OF A STANDARD SET OF SOFTWARE INDICATORS FOR AERONAUTICAL SYSTEMS CENTER M.S. Thesis**

Bradley J. Ayers and William M. Rock Sep. 1992 412 p

(AD-A258424; AFIT/GSS/ENC/92D-1) Avail: CASI HC A18/MF A04

This research effort was directed to the development of a standard set of software indicators to be used by ASC. The research was sponsored by ASC/ENASC, who indicated their desire for such a standard set of indicators to allow a database to be developed of program data that would be useful in making predictions about future software efforts. The research began with an attempt to characterize the software indicator environment at ASC, and also to perform a literature search for software indicators currently available. The desired result was an initial core set of indicators useful to software managers and engineers and to ENASC and also a methodology for the continuous refinement of the set of indicators as part of a process to better define the software indicator environment. Thirty-four interviews were done on software managers and engineers, and the results showed some common areas of interest, some unique interests for managers, and some for engineers. GRA

**N93-17867#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**UNIT ANALYSIS AND TESTING Final Report**

Larry J. Morell and Lionel E. Deimel Jun. 1992 56 p

(Contract F19628-90-C-0003)

(AD-A258435; SEI-CM-9-2.0) Avail: CASI HC A04/MF A01

This module examines the techniques, assessment, and management of unit analysis and testing. Analysis strategies are classified according to the view they take of the software: textual, syntactic, control flow, data flow, computation flow, or functional. Testing strategies are categorized according to whether their coverage goal is specification-oriented, implementation-oriented, error-oriented, or a combination of these. Mastery of the material in this module allows the software engineer to define, conduct, and evaluate unit analyses and tests and to assess new techniques proposed in the literature. GRA

**N93-17872#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**AN EFFICIENT ALGORITHM FOR THE COMPUTATION OF GALERKIN COARSE GRID APPROXIMATION FOR THE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS**

S. Zeng and P. Wesseling 1992 30 p

(Rept-92-40; ETN-93-93131) Copyright Avail: CASI HC A03/MF A01

A way to compute coarse grid matrices efficiently (algorithm CALRAP) with the non zero pattern of coarse grid matrices determined by the algorithm STRURAP is discussed for operator independent prolongations and restrictions with boundary modifications, assuming that the discretization matrix on the finest grid is derived from a scalar partial differential equation. By means of partition of grids, the computation of coarse grid matrices near boundaries is well treated in the same way as for interior grid points, with neither introducing 'if-then' statements nor distinguishing between interior and boundary cases in the inner most loop of the algorithm CALRAP, which is expected to give an efficient computation of coarse grid matrices. Quasi ALGOL descriptions of the two algorithms are developed, which can be used as predesigns for practical FORTRAN codes. A generalization of the algorithms is presented for the case that the discretization matrix is derived from a set of partial differential equations, particularly the incompressible Navier-Stokes equations, discretized on a staggered grid. A quasi ALGOL description of the generalization is also given. ESA

**N93-17885*#** Research Inst. for Computing and Information Systems, Houston, TX.

**REPOSITORY-BASED SOFTWARE ENGINEERING PROGRAM Interim Progress Report**

James Wilson Sep. 1992 51 p Prepared in cooperation with Applied Expertise, Inc., Houston, TX

(Contract NCC9-16; RICIS Proj. RB-04)

(NASA-CR-191653; NAS 1.26:191653) Avail: CASI HC A04/MF A01

The activities performed during September 1992 in support of Tasks 01 and 02 of the Repository-Based Software Engineering Program are outlined. The recommendations and implementation strategy defined at the September 9-10 meeting of the Reuse Acquisition Action Team (RAAT) are attached along with the viewgraphs and reference information presented at the Institute for Defense Analyses brief on legal and patent issues related to software reuse. Author

**N93-17892#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.

**THE APPLICATION OF FUNCTION POINTS TO PREDICT SOURCE LINES OF CODE FOR SOFTWARE DEVELOPMENT M.S. Thesis**

Garland S. Henderson Sep. 1992 202 p

(AD-A258447; AFIT/GCA/LSY-92S-4) Avail: CASI HC A10/MF A03

This research investigated the results of using function point analysis-based estimates to predict source lines of code (SLOC) for software development projects. The majority of software cost and effort estimating parametric tools are categorized as SLOC-based, meaning SLOC is the primary input. Early in a program, an accurate estimate of SLOC is difficult to project. Function points, another parametric software estimating tool, bases software cost and effort estimates on the functionality of a system. This functionality is described by documents available early in a program. Using a modeling methodology, the research focuses on function point's ability to accurately estimate SLOC in the military and commercial environments. Although a significant relationship exists in both environments, none of the models provided a goodness of fit, predictive capability, and significance level to make them acceptable models, especially noted in the variability of the estimates of SLOC. The need to use models developed in similar environments was made clear. The concept of function point to SLOC conversion tables was assessed and was justified. However, the conversion tables to be used should be based on similar programs developed in similar environments. Universally applicable function point to SLOC conversion tables were not supported by this research. GRA

**N93-17898#** North Carolina Univ., Chapel Hill.

**METHODS AND CONVERGENCE ANALYSIS IN LARGE SCALE NONLINEAR OPTIMIZATION Final Report, 1 Sep. 1988 - 31 Jul. 1992**

Jon W. Toole Oct. 1992 4 p

(Grant AF-AFOSR-0267-88)

(AD-A258182; AFOSR-92-0970TR) Avail: CASI HC A01/MF A01

A new algorithm for the solution of large-scale nonlinear constrained optimization problems has been developed. The algorithm has been used to solve some optimal control problems with promising results. GRA

**N93-17905#** Naval Postgraduate School, Monterey, CA.
**RE-ENGINEERING SOFTWARE SYSTEMS IN THE DEPARTMENT OF DEFENSE USING INTEGRATED COMPUTER AIDED SOFTWARE ENGINEERING TOOLS M.S. Thesis**
Charles A. Jennings 24 Sep. 1992 132 p
(AD-A257500) Avail: CASI HC A07/MF A02

The Department of Defense (DoD) is plagued by severe cost overruns and delays in developing software systems. Existing software within DoD, some developed 15 to 20 years ago, require continual maintenance and modification. Major difficulties arise with maintaining older systems due to cryptic source code and a lack of adequate documentation. To remedy this situation, the DoD, is pursuing the integrated computer aided software engineering (I-CASE) procurement as a means to improve DoD's development and maintenance of software systems. This study focuses on the concepts and theory behind software re-engineering. In particular, it studies the current state of I-CASE technology, and the feasibility of re-engineering existing software systems for migration to an I-CASE environment. GRA

**N93-17983#** Naval Postgraduate School, Monterey, CA.
**MODELING PROCESS REDESIGN M.S. Thesis**
Scott A. White Sep. 1992 93 p
(AD-A257561) Avail: CASI HC A05/MF A01

This thesis introduces the usage of the IDEF (ICAM Integrated Computer Manufacturing Definitions Language) methodology to model process redesign. A research team was assembled at the Naval Postgraduate School in Monterey, California to attend a five-day IDEF conference to create a model of process redesign. This model will be used to develop a handbook for functional managers to evaluate and redesign their own business processes. GRA

**N93-18011#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
**SOFTWARE ENGINEERING PROCESS GROUPS: RESULTS OF THE 1992 SEPG WORKSHOP EVENT EVALUATION AND A FIRST REPORT ON SEPG STATUS Final Report**
Mark D. Miller and Dennis R. Goldenson Aug. 1992 55 p Workshop held in Tysons Corner, VA, Apr. 1992
(Contract F19628-90-C-0003)
(AD-A258259; CMU/SEI-92-SR-13) Avail: CASI HC A04/MF A01

This report contains a summary of the results from a questionnaire administered to participants in the Software Engineering Process Group (SEPG) Workshop held in Tysons Corner, Virginia, in April of 1992. The purpose of the questionnaire was twofold: (1) to ask the participants for their judgments about the quality of the week-long event, and (2) to begin collecting information comparing the experiences of existing SEPG's. The participants reported a generally high degree of satisfaction with the content and conduct of the event. Although descriptions about SEPG characteristics and activities apply only to the organizations whose representatives attended the workshop, our findings suggest recent and rapid growth in the SEPG community. Of the 169 responding participants, 72 percent stated that their organizations have SEPG's, and over three-quarters of the SEPG's have been established since 1990. GRA

**N93-18024#** Defence Research Agency, Malvern (England).
**THE DYNAMIC SEMANTICS OF KERNEL ELLA Memorandum Report**
M. G. Hill Aug. 1992 52 p
(AD-A258221; DRA-Memo-4630; DRIC-BR-313436) Avail: CASI HC A04/MF A01

This document describes the dynamic semantics of the Kernel of ELLA. The Kernel is a set of data structures into which any ELLA circuit can be transformed. The semantics of two simple languages are explored in order to demonstrate the implementability of the approach undertaken. Correspondence between this work and former analysis is shown. GRA

**N93-18025#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
**A REUSE-BASED SOFTWARE DEVELOPMENT METHODOLOGY Final Report**
Kyo C. Kang, Sholom Cohen, Robert Holibaugh, James Perry, and A. S. Peterson May 1992 34 p
(Contract F19628-90-C-0003)
(AD-A258255; CMU/SEI-92-SR-4) Avail: CASI HC A03/MF A01

Software has been reused in applications development ever since programming started. However, the reuse practices have mostly been ad hoc, and the potential benefits of reuse have never been fully realized. Most of the available software development methodologies do not explicitly identify reuse activities. The Application of Reusable Software Components Project of the Software Engineering Institute is developing a reuse-based software development methodology, and the current direction and the progress of the methodology work are discussed in this paper. The methodology is based on the life cycle model in DoD-STD-2167A with refinement of each phase to identify reuse activities. The reuse activities that are common across the life cycle phases are identified as: (1) studying the problem and available solutions to the problem and developing a reuse plan or strategy, (2) identifying a solution structure for the problem following the reuse plan, (3) reconfiguring the solution structure to improve reuse at the next phase, (4) acquiring, instantiating, and/or modifying existing reusable components, (5) integrating the reused and any newly developed components into the products for the phase, and (6) evaluating the products. These activities are used as the base model for defining the specific activities at each phase of the life cycle. GRA

**N93-18076#** Societe Europeenne de Propulsion, Vernon (France).
**THE PRODUCT AND SERVICES DESIGN AND DEVELOPMENT SOFTWARE AIDED TOOL RELIASEP [LE LOGICIEL RELIASEP OUTIL D'AIDE A LA CONCEPTION AU DEVELOPPEMENT DE PRODUIT ET SERVICES]**
R. Vogin, G. Sciez, and J. P. Pitton 1992 7 p In FRENCH Presented at Colloque Lambda-Mu, Grenoble, France, 6-8 Oct. 1992
(ETN-93-93015) Avail: CASI HC A02/MF A01

The RELIASEP safe design method is reported. The main steps of the methodology (functional analysis, Failure Modes, Effects, and Criticality Analysis (FMECA), and management of actions for risks reduction) are described and the software which supports the methodology is presented. The tool which is very easy to use and is consistent with the RELIASEP method and its data bank, provides the designer with a real help. Reflexion is structure. All the designs, or FMECA sheets recorded in the system, are quickly accessible on request. The data bank is automatically updated. RELIASEP is a technical memory, which allows efficient implementation of past experience and a product in the course of the development. ESA

**N93-18081#** Kestrel Inst., Palo Alto, CA.
**THEORY OF ALGORITHM STRUCTURE AND DESIGN Report, 1 Oct. 1989 - 30 Sep. 1992**
Douglas R. Smith 30 Sep. 1992 19 p
(Contract N00014-90-J-1733)
(AD-A257948) Avail: CASI HC A03/MF A01

Algorithms and data structures are among the primary constituents of computer software and thus are among basic objects of study in computer science. This project is concerned with the structure and automated design of algorithms and data structures. Our scientific hypothesis is that there exists general algorithm, data structure, and design concepts that underlie and explain most of the detailed structure of conventional software systems. By abstracting and formalizing these concepts and showing how to mechanize their application, we can prepare the way for the coming generation of automated software design environments. Our approach involves identifying classes of algorithms that solve a broad range of useful problems. In particular we have emphasized formalizing abstract algorithms that make minimal assumptions about the structure of a problem. Once a class of algorithms has been identified we represent its essence as a theory, called an algorithm theory. GRA

**N93-18112*#** Research Inst. for Computing and Information Systems, Houston, TX.
**TUNS/TCIS INFORMATION MODEL/PROCESS MODEL**
James Wilson 26 Oct. 1992 88 p Prepared in cooperation with Applied Expertise, Inc., Houston, TX
(Contract NCC9-16; RICIS Proj. RB-04)
(NASA-CR-191654; NAS 1.26:191654) Avail: CASI HC A05/MF A01

An Information Model is comprised of graphical and textual notation suitable for describing and defining the problem domain - in our case, TUNS or TCIS. The model focuses on the real world under study. It

identifies what is in the problem and organizes the data into a formal structure for documentation and communication purposes. The Information Model is composed of an Entity Relationship Diagram (ERD) and a Data Dictionary component. The combination of these components provide an easy to understand methodology for expressing the entities in the problem space, the relationships between entities and the characteristics (attributes) of the entities. This approach is the first step in information system development. The Information Model identifies the complete set of data elements processed by TUNS. This representation provides a conceptual view of TUNS from the perspective of entities, data, and relationships. The Information Model reflects the business practices and real-world entities that users must deal with. Author

**N93-18198** Politecnico di Milano (Italy). Dipt. di Elettronica.
**G-LOG: A GRAPH BASED QUERY LANGUAGE**
Jan Paredaens (Antwerp Univ., Belgium ), Peter Peelman (Antwerp Univ., Belgium ), and Letizia Tanca Jun. 1992 46 p Sponsored by CNR, and Diensten voor Programmatie van het Wetenschapsbeleid
(Rept-92-013; ETN-93-93031) Avail: Politecnico di Milano, Piazza Leonardo da Vinci, 20133 Milan, Italy

G-LOG, a declarative query language based on graphs, which combines the expressive power of logic, the modeling of object orientedness, and the representation power of graphs, is described. G-LOG is compared to well known deductive database languages: G-LOG is a non deterministic complete query language, thus allowing the expression of a large variety of queries. As in the case of PROLOG, G-LOG may be used in a totally declarative way, as well as in a 'more procedural' way. Thus, it provides an intuitive, flexible graphical formalism for nonexpert database users. ESA

**N93-18199** Politecnico di Milano (Italy). Dipt. di Electtronica e Informazione.
**INTEGRATION OF DEDUCTIVE AND OBJECT ORIENTED DATA BASES: THEORETICAL AND IMPLEMENTATION ASPECTS Ph.D. Thesis [L'INTEGRATION DI BASI DI DATI DEDUTTIVE ED ORIENTATE A OGGETTI: ASPETTI TEORICI E REALIZZATIVI]**
Filippo Cacace Jun. 1992 157 p In ITALIAN
(Rept-92-039; ETN-93-93036) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

The LOGRES language and system are presented. LOGRES is a project for the development of new database systems which is based on the integration of the object oriented data modeling paradigm and of the rule based approach for the specification of queries and updates. The data model supports generalization hierarchies and object sharing; the rule based language extends DATALOG to support generalized type constructors (sets, multisets, and sequences); rule based integrity constraints are automatically produced by analyzing schema definitions. Modularization is a fundamental feature, as modules encapsulate queries and updates; when modules are applied to a LOGRES database, their side effects can be controlled. A formal definition of the language and data model is given. Formal properties of the language, with respect to nondeterminism, consistency, expressive power and concurrency, are investigated. The implementation of the LOGRES prototype and optimization methods are described. ESA

**N93-18224*#** Research Inst. for Computing and Information Systems, Houston, TX.
**FUZZY SET METHODS FOR OBJECT RECOGNITION IN SPACE APPLICATIONS Quarterly Report No. 4 and Final, 1 Apr. - 30 Jun. 1992**
James M. Keller, ed. (Missouri Univ., Columbia.) 30 Jun. 1992 79 p
(Contract NCC9-16; RICIS Proj. SE-42)
(NASA-CR-191975; NAS 1.26:191975) Avail: CASI HC A05/MF A01

Progress on the following four tasks is described: (1) fuzzy set based decision methodologies; (2) membership calculation; (3) clustering methods (including derivation of pose estimation parameters), and (4) acquisition of images and testing of algorithms. For individual titles, see N93-18225 through N93-18228.

**N93-18225*#** Missouri Univ., Columbia. Dept. of Electrical and Computer Engineering.
**AUTOMATIC RULE GENERATION FOR HIGH-LEVEL VISION**
Frank Chung-Hoon Rhee and Raghu Krishnapuram *In* RICIS, Fuzzy Set Methods for Object Recognition in Space Applications 30 Jun. 1992 17 p (For primary document see N93-18224 06-61)
Avail: CASI HC A03/MF A01

A new fuzzy set based technique that was developed for decision making is discussed. It is a method to generate fuzzy decision rules automatically for image analysis. This paper proposes a method to generate rule-based approaches to solve problems such as autonomous navigation and image understanding automatically from training data. The proposed method is also capable of filtering out irrelevant features and criteria from the rules. Author

**N93-18226*#** Missouri Univ., Columbia. Dept. of Electrical and Computer Engineering.
**POSSIBILITY EXPECTATION AND ITS DECISION MAKING ALGORITHM**
James M. Keller and Bolin Yan *In* RICIS, Fuzzy Set Methods for Object Recognition in Space Applications 30 Jun. 1992 16 p (For primary document see N93-18224 06-61)
Avail: CASI HC A03/MF A01

The fuzzy integral has been shown to be an effective tool for the aggregation of evidence in decision making. Of primary importance in the development of a fuzzy integral pattern recognition algorithm is the choice (construction) of the measure which embodies the importance of subsets of sources of evidence. Sugeno fuzzy measures have received the most attention due to the recursive nature of the fabrication of the measure on nested sequences of subsets. Possibility measures exhibit an even simpler generation capability, but usually require that one of the sources of information possess complete credibility. In real applications, such normalization may not be possible, or even desirable. In this report, both the theory and a decision making algorithm for a variation of the fuzzy integral are presented. This integral is based on a possibility measure where it is not required that the measure of the universe be unity. A training algorithm for the possibility densities in a pattern recognition application is also presented with the results demonstrated on the shuttle-earth-space training and testing images. Author

**N93-18227*#** Missouri Univ., Columbia.
**MEMBERSHIP GENERATION USING MULTILAYER NEURAL NETWORK**
Jaeseok Kim *In* RICIS, Fuzzy Set Methods for Object Recognition in Space Applications 30 Jun. 1992 12 p (For primary document see N93-18224 06-61)
Avail: CASI HC A03/MF A01

There has been intensive research in neural network applications to pattern recognition problems. Particularly, the back-propagation network has attracted many researchers because of its outstanding performance in pattern recognition applications. In this section, we describe a new method to generate membership functions from training data using a multilayer neural network. The basic idea behind the approach is as follows. The output values of a sigmoid activation function of a neuron bear remarkable resemblance to membership values. Therefore, we can regard the sigmoid activation values as the membership values in fuzzy set theory. Thus, in order to generate class membership values, we first train a suitable multilayer network using a training algorithm such as the back-propagation algorithm. After the training procedure converges, the resulting network can be treated as a membership generation network, where the inputs are feature values and the outputs are membership values in the different classes. This method allows fairly complex membership functions to be generated because the network is highly nonlinear in general. Also, it is to be noted that the membership functions are generated from a classification point of view. For pattern recognition applications, this is highly desirable, although the membership values may not be indicative of the degree of typicality of a feature value in a particular class. Author

**N93-18228*#** Missouri Univ., Columbia. Dept. of Electrical and Computer Engineering.
**POSSIBILISTIC CLUSTERING FOR SHAPE RECOGNITION**
James M. Keller and Raghu Krishnapuram *In* RICIS, Fuzzy Set Methods for Object Recognition in Space Applications 30 Jun. 1992 20 p (For primary document see N93-18224 06-61)
Avail: CASI HC A03/MF A01

Clustering methods have been used extensively in computer vision and pattern recognition. Fuzzy clustering has been shown to be advantageous over crisp (or traditional) clustering in that total commitment

of a vector to a given class is not required at each iteration. Recently fuzzy clustering methods have shown spectacular ability to detect not only hypervolume clusters, but also clusters which are actually 'thin shells', i.e., curves and surfaces. Most analytic fuzzy clustering approaches are derived from Bezdek's Fuzzy C-Means (FCM) algorithm. The FCM uses the probabilistic constraint that the memberships of a data point across classes sum to one. This constraint was used to generate the membership update equations for an iterative algorithm. Unfortunately, the memberships resulting from FCM and its derivatives do not correspond to the intuitive concept of degree of belonging, and moreover, the algorithms have considerable trouble in noisy environments. Recently, we cast the clustering problem into the framework of possibility theory. Our approach was radically different from the existing clustering methods in that the resulting partition of the data can be interpreted as a possibilistic partition, and the membership values may be interpreted as degrees of possibility of the points belonging to the classes. We constructed an appropriate objective function whose minimum will characterize a good possibilistic partition of the data, and we derived the membership and prototype update equations from necessary conditions for minimization of our criterion function. In this paper, we show the ability of this approach to detect linear and quartic curves in the presence of considerable noise. Author

**N93-18243#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**SOFTWARE PROCESS DEVELOPMENT AND ENACTMENT: CONCEPTS AND DEFINITIONS Final Report**

Peter H. Feiler and Watts S. Humphrey Sep. 1992 35 p
(Contract F19628-90-C-0003)
(AD-A258465; CMU/SEI-92-TR-04; ESD-TR-92-04) Avail: CASI HC A03/MF A01

The scientific treatment of the software process is relatively new and, as with any new field, the initial terminology is often confusing. When terms can have a diversity of meanings, technical communication is more difficult and technological progress is constrained. This paper defines a core set of concepts about the software process. These concepts are intended to facilitate communications and to provide a framework for further definitions. The definitions focus on essential concepts; however, they do not represent a comprehensive glossary of common software process terms. Following an initial overview, this paper outlines the basic process concepts which underlie the definitions. The definitions are then grouped in four sets: a framework for process definition, an engineering of process, an enactment of process, and process properties. This is followed by illustrations of the use of these concepts in several domains. The paper concludes with some observations on the definition process. GRA

**N93-18250#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**SOFTWARE MEASUREMENT FOR DOD SYSTEMS: RECOMMENDATIONS FOR INITIAL CORE MEASURES Final Report**

Anita D. Carleton, Robert E. Park, Wolfhart B. Goethert, William A. Florac, and Elizabeth K. Bailey Sep. 1992 62 p
(Contract F19628-90-C-0003)
(AD-A258305; CMU/SEI-92-TR-19; ESC/XC-TR-92-019) Avail: CASI HC A04/MF A01

This report presents our recommendations for a basic set of software measures that Department of Defense (DoD) organizations can use to help plan and manage the acquisition, development, and support of software systems. These recommendations are based on work that was initiated by the Software Metrics Definition Working Group and subsequently extended by the SEI to support the DoD Software Action Plan. The central theme is the use of checklists to create and record structured measurement descriptions and reporting specifications. These checklists provide a mechanism for obtaining consistent measures from project to project and for communicating unambiguous measurement results. GRA

**N93-18268#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**A CLASSIFICATION AND BIBLIOGRAPHY OF SOFTWARE PROTOTYPING Final Report**

David P. Wood and Kyo C. Kang Oct. 1992 93 p
(Contract F19628-90-C-0003)
(AD-A258466; CMU/SEI-92-TR-13; ESC-TR-92-013) Avail: CASI HC A05/MF A01

Prototyping, the creation and enaction of models based on operational scenarios, has been advocated as a useful software engineering paradigm because it lends itself to intense interaction between customers, users, and developers, resulting in early validation of specifications and designs. An extensive and widespread interest in software prototyping in recent years has resulted in a daunting amount of literature and dozens of proposed methods and tools. As with any immature and growing technology, the expanding literature and approaches have resulted in correspondingly expansive and confusing terminology. An overview of technology and literature relating to the creation and use of software system prototypes is presented. In addition to an annotated bibliography of recent prototyping literature, a technology framework, taxonomy, and series of classifications are provided. The intent of this report is to provide a basic road map through the available literature and technology. GRA

**N93-18269#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**A CONCEPTUAL FRAMEWORK FOR SYSTEM FAULT TOLERANCE Final Report**

Walter L. Heimerdinger and Charles B. Weinstock Nov. 1992 42 p
(Contract F19628-90-C-0003)
(AD-A258467; CMU/SEI-92-TR-33; ESC-TR-92-033) Avail: CASI HC A03/MF A01

A major problem in transitioning fault tolerance practices to the practitioner community is a lack of a common view of what fault tolerance is, and how it can help in the design of reliable computer systems. This document takes a step towards making fault tolerance more understandable by proposing a conceptual framework. The framework provides a consistent vocabulary for fault tolerance concepts, discusses how systems fail, describes commonly used mechanisms for making systems fault tolerant, and provides some rules for developing fault tolerant systems. GRA

**N93-18271#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**ANALYSIS OF A SOFTWARE MAINTENANCE SYSTEM: A CASE STUDY Final Report**

Howard M. Slomer and Alan M. Christie Nov. 1992 84 p
(Contract F19628-89-C-0003)
(AD-A258469; CMU/SEI-92-TR-31; ESC-TR-92-031) Avail: CASI HC A05/MF A01

To design, implement, and operate a successful software development process, exposure to similar existing systems is invaluable. An existing, moderate size, software maintenance project is documented and analyzed. The project, which supports the maintenance of a software environment has, through incremental improvement, become very effective. However, this effectiveness has only been achieved through struggle, compromise, and creativity. The evolution of the project, providing insights into how change was managed, is documented and the project is defined and formally modeled as it existed until recently. The projects process is still evolving, and recent changes, while not formally modeled, are also described. The results of this modeling are applied (1) to compare the project's practices from a perspective of the SEI Capability Maturity Model (CMM), and (2) to address briefly the issue of process reuse. Comparison to the CMM resulted in an identification of strengths and weaknesses of the project's software process. In the examination of reuse issues, three hypothetical examples of process reuse are capability maturity model, configuration management, and software maintenance systems. GRA

**N93-18282*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**GENERAL METHOD OF PATTERN CLASSIFICATION USING THE TWO-DOMAIN THEORY Patent**

Mark E. Rorvig, inventor (to NASA) 19 Jan. 1993 11 p Filed 25 Sep. 1990 Supersedes N91-13911 (29 - 5, p 702)
(NASA-Case-MSC-21737-1; US-Patent-5,181,259;
US-Patent-Appl-SN-587922; US-Patent-Class-382-36;
US-Patent-Class-382-1; US-Patent-Class-382-6; Int-Patent-Class-G06K-9/00)
Avail: US Patent and Trademark Office

Human beings judge patterns (such as images) by complex mental processes, some of which may not be known, while computing machines

extract features. By representing the human judgements with simple measurements and reducing them and the machine extracted features to a common metric space and fitting them by regression, the judgements of human experts rendered on a sample of patterns may be imposed on a pattern population to provide automatic classification.
Official Gazette of the U.S. Patent and Trademark Office

**N93-18303#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
**SOFTWARE SIZE MEASUREMENT: A FRAMEWORK FOR COUNTING SOURCE STATEMENTS Final Report**
Robert E. Park Sep. 1992 226 p
(Contract F19628-90-C-0003)
(AD-A258304; CMU/SEI/92-TR-20; ESC-TR-92-020) Avail: CASI HC A11/MF A03

This report presents guidelines for defining, recording, and reporting two frequently used measures of software size-physical source lines and logical source statements. We propose a general framework for constructing size definitions and use it to derive operational methods can be applied to address the information needs of different users while maintaining a common definition of software size. GRA

**N93-18325** Politecnico di Milano (Italy). Dipt. di Elettronica.
**THE RUDES AND THE SHREWDS: AN EXPERIMENTAL COMPARISON OF SEVERAL EVOLUTIONARY HEURISTICS APPLIED TO THE QAP PROBLEM**
Vittorio Maniezzo Oct. 1991 21 p
(Rept-91-042; ETN-93-93030) Avail: Politecnico di Milano, Piazza Leonardo da Vinci, 20133 Milan, Italy

Several evolutionary heuristic algorithms are compared with each other by applying them to a well defined combinatorial optimization problem. The Quadratic Assignment Problem (QAP), reputedly one of the most difficult combinatorial optimization problems, is considered; QAP is merely used as a carrier for the comparison and no attempt is made to compare any heuristic with tailored approximation algorithms. Results are given, both with respect to the best result achieved by each algorithm in a limited time span and to its speed of convergence to that result. ESA

**N93-18332*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**APPLICATION OF A NEURAL NETWORK AS A POTENTIAL AID IN PREDICTING NTF PUMP FAILURE**
James L. Rogers, Jeffrey S. Hill, William J. LaMarsh, II (Unisys Corp., Hampton, VA.), and David E. Bradley Jan. 1993 12 p
(RTOP 505-63-50-06)
(NASA-TM-107667; NAS 1.15:107667) Avail: CASI HC A03/MF A01

The National Transonic Facility has three centrifugal multi-stage pumps to supply liquid nitrogen to the wind tunnel. Pump reliability is critical to facility operation and test capability. A highly desirable goal is to be able to detect a pump rotating component problem as early as possible during normal operation and avoid serious damage to other pump components. If a problem is detected before serious damage occurs, the repair cost and downtime could be reduced significantly. A neural network-based tool was developed for monitoring pump performance and aiding in predicting pump failure. Once trained, neural networks can rapidly process many combinations of input values other than those used for training to approximate previously unknown output values. This neural network was applied to establish relationships among the critical frequencies and aid in predicting failures. Training pairs were developed from frequency scans from typical tunnel operations. After training, various combinations of critical pump frequencies were propagated through the neural network. The approximated output was used to create a contour plot depicting the relationships of the input frequencies to the output pump frequency. Author

**N93-18373*#** Mississippi State Univ., Mississippi State. Dept. of Electrical and Computer Engineering.
**AN INVESTIGATION OF ERROR CHARACTERISTICS AND CODING PERFORMANCE Semiannual Report No. 1, 1 Jul. - 30 Dec. 1992**
William J. Ebel and Frank M. Ingels Dec. 1992 34 p
(Grant NAG5-2006)
(NASA-CR-191899; NAS 1.26:191899) Avail: CASI HC A03/MF A01

The performance of forward error correcting coding schemes on errors anticipated for the Earth Observation System (EOS) Ku-band downlink are studied. The EOS transmits picture frame data to the ground via the Telemetry Data Relay Satellite System (TDRSS) to a ground-based receiver at White Sands. Due to unintentional RF interference from other systems operating in the Ku band, the noise at the receiver is non-Gaussian which may result in non-random errors output by the demodulator. That is, the downlink channel cannot be modeled by a simple memoryless Gaussian-noise channel. From previous experience, it is believed that those errors are bursty. The research proceeded by developing a computer based simulation, called Communication Link Error ANalysis (CLEAN), to model the downlink errors, forward error correcting schemes, and interleavers used with TDRSS. To date, the bulk of CLEAN was written, documented, debugged, and verified. The procedures for utilizing CLEAN to investigate code performance were established and are discussed. Author

**N93-18382*#** Analex Corp., Brook Park, OH.
**ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE HIGH BURST RATE LINK EVALUATION TERMINAL EXPERIMENT CONTROL AND MONITOR SOFTWARE USER'S GUIDE, VERSION 1.0**
Richard C. Reinhart Dec. 1992 82 p
(Contract NAS3-25776; RTOP 650-60-23)
(NASA-CR-189160; E-6981; NAS 1.26:189160) Avail: CASI HC A05/MF A01

The Experiment Control and Monitor (EC&M) software was developed at NASA Lewis Research Center to support the Advanced Communications Technology Satellite (ACTS) High Burst Rate Link Evaluation Terminal (HBR-LET). The HBR-LET is an experimenter's terminal to communicate with the ACTS for various investigations by government agencies, universities, and industry. The EC&M software is one segment of the Control and Performance Monitoring (C&PM) software system of the HBR-LET. The EC&M software allows users to initialize, control, and monitor the instrumentation within the HBR-LET using a predefined sequence of commands. Besides instrument control, the C&PM software system is also responsible for computer communication between the HBR-LET and the ACTS NASA Ground Station and for uplink power control of the HBR-LET to demonstrate power augmentation during rain fade events. The EC&M Software User's Guide, Version 1.0 (NASA-CR-189160) outlines the commands required to install and operate the EC&M software. Input and output file descriptions, operator commands, and error recovery procedures are discussed in the document. Author

**N93-18414*#** Maryland Univ., College Park.
**FORWARD MODEL AND CO RETRIEVAL ALGORITHM Progress Report**
L. L. Strow and S. E. Hannon 19 Sep. 1992 20 p
(Contract NAS5-31378)
(NASA-CR-191306; NAS 1.26:191306) Avail: CASI HC A03/MF A01

A progress report on the forward model and CO retrieval algorithm is presented. For the forward model, the fast-transmittance algorithm is discussed including monochromatic calculations, determination of fast-transmittance parameters, and regression errors. Simulations, retrieval technique, and sensitivity of the CO retrieval algorithm are discussed.
L.R.R.

**N93-18433#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.
**A PARALLEL STEREO ALGORITHM THAT PRODUCES DENSE DEPTH MAPS AND PRESERVES IMAGE FEATURES [UN ALGORITHME STEREO PARALLELES CALCUL DE CARTES DE PROFONDEUR DENSES QUI PRESERVENT LES DISCONTINUITES]**
Pascal Fua Jan. 1991 24 p Submitted for publication
(INRIA-RR-1369; ETN-93-92628) Avail: CASI HC A03/MF A01

To compute reliable dense depth maps a stereo algorithm must preserve depth discontinuities and avoid gross errors. The combination of simple and parallel techniques to achieve this goal and deal with complex real world scenes is demonstrated. The algorithm relies on correlation followed by interpolation. During the correlation phase, the two images play a symmetric role and a validity criterion is used for the matches that eliminate gross errors: at places where the images cannot be correlated reliably, due to lack of texture or exclusions for example, the algorithms does not produce wrong matches but a very sparse disparity map as opposed to a

dense one when the correlation is successful. To generate dense depth map, the information is then propagated across the featureless areas but not across discontinuities by an interpolation scheme that takes image gray levels into account to preserve image features. The algorithm performs very well on difficult images such as faces and cluttered ground level scenes. Because all the algorithms described are parallel and very regular, they could be implemented in hardware and lead to extremely fast stereo systems. ESA

**N93-18450#** Stanford Univ., CA. Systems Optimization Lab.
**BRACKETING TO SPEED CONVERGENCE ILLUSTRATED ON THE VON NEWMANN ALGORITHM FOR FINDING A FEASIBLE SOLUTION TO A LINEAR PROGRAM WITH A CONVEXITY CONSTRAINT**
G. B. Dantzig Oct. 1992 12 p
(Contract DE-FG03-92ER-25116)
(DE93-002660; SOL-92-6) Avail: CASI HC A03/MF A01

Analogous to gunners firing trial shots to bracket a target in order to adjust direction and distance, we demonstrate that is is sometimes faster not to apply an algorithm directly, but to roughly approximately solve several perturbations of the problem and then combine these rough approximations to get an exact solution. To find a feasible solution to an m-equation linear program with a convexity constraint, the von Neumann Algorithm generates a sequence of approximate solutions which converge very slowly to the right hand side b(sup 0). However, it can be redirected so that in the first few iterations it is guaranteed to move rapidly towards the neighborhood of one of m + 1 perturbed right hand sides vector-b(sup i), then redirected in turn to the next vector-b(sup i). Once within the neighborhood of each vector-b(sup i), a weighted sum of the approximate solutions. Bar-x(sup i) yields the exact solution of the unperturbed problem where the weights are found by solving a system of m + 1 equations in m + 1 unknowns. It is assumed an r greater than 0 is given for which the problem is feasible for all right hand sides b whose distance (b - b(sup 0))(sub 2) less than or equal to r. The feasible solution is found in less than 4(m + 1)(exp 3)/r(exp 2) iterations. The work per iteration is (delta)mn + 2m + n + 9 multiplications plus (delta)mn + m + n + 9 additions or comparisons where delta is the density of nonzero coefficients in the matrix. DOE

**N93-18455#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.
**RANDOMIZATION YIELDS SIMPLE O(n LOG* n) ALGORITHMS FOR DIFFICULT OMEGA(n) PROBLEMS [LA RANDOMISATION PERMET LA CONSTRUCTION D'ALGORITHMES SIMPLES EN O(N LOG* N) POUR DES PROBLEMES LINEAIRES DIFFICILES]**
Olivier Devillers Apr. 1991 17 p Sponsored in part by Commission of the European Communities
(INRIA-RR-1412; ETN-93-92637) Avail: CASI HC A03/MF A01

The results on the influence graph from a study on applications of random sampling to online algorithms in computational geometry are used to adapt them for particular cases where it is possible to improve the expected randomized complexity of algorithms from O(n log n), to O(n log* n). This technique applies in the following applications: triangulation of a simple polygon, medial axis of a simple polygon, Delaunay triangulation of vertices of a convex polygon, and Delaunay triangulation of points knowing the minimum spanning tree. ESA

**N93-18513#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.
**IMPLEMENTATION OF INHERITANCE BY MEANS OF RELATIONS [MISE EN OEUVRE DE L'HERITAGE AU MOYEN DE RELATIONS]**
Mireille Fornarino Apr. 1991 38 p In FRENCH
(INRIA-RR-1417; ETN-93-92639) Avail: CASI HC A03/MF A01

A modeling of the inheritance mechanism usually predefined, in terms of information propagation along inheritance links is implemented. The inheritance mechanism is a way to share and factorize information in object oriented languages. Depending on application domains, it is used to express strict specialization or other kinds of relations such as instanciation or composition. Its semantics is then more or less clearly established and its use is more or less strict. Each transfer in the modeling between two given objects is realized by means of link to model. Inheritance then acts by message sending to the different protagonists; each object has both a functional and a relational interface. So the encapsulation principle is better preserved. In the resulting system, the user can define several sorts of inheritance relations, specific to the knowledge to be modeled, and at the same time he can specify their semantics. The resulting system is thus both more expressive and more constrained. ESA

**N93-18519#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 6: Calcul Scientifique, Modelisation et Logiciels Numeriques.
**ORCCAD: TOWARDS AN OPEN ROBOT CONTROLLER COMPUTER AIDED DESIGN SYSTEM [ORCCAD: UN SYSTEME DE CAO POUR CONTROLEUR OUVERT EN ROBOTIQUE]**
Antoine Joubert (Ecole Nationale Superieure des Mines, Valbonne, France) and Daniel Simon Feb. 1991 23 p Sponsored in part by Commission of the European Communities
(INRIA-RR-1396; ETN-93-92632) Avail: CASI HC A03/MF A01

The implementation of robotics tasks via various robot controller architectures using the ORCCAD system is addressed. The development of new robotic tasks deals with many different techniques and scientific fields. Automatic control is involved in control laws analysis while computer science tools are used to produce efficient real time programs. Following the development of a full example, a methodology for the design of new robotics tasks and a review of the tools to be used at each step of the task development, are given. ESA

**N93-18568#** Sheffield Univ. (England). Dept. of Control Engineering.
**AN ORTHOGONAL ESTIMATION ALGORITHM FOR COMPLEX NUMBER SYSTEMS**
K. M. Tsang (Hong Kong Polytechnic, Kowloon.) and S. A. Billings Aug. 1990 11 p
(RR-405; ETN-92-92764) Avail: CASI HC A03/MF A01

An orthogonal estimation algorithm for complex number systems is derived. It is shown that a modified error reduction ratio test together with the orthogonal estimation algorithm provides an efficient way of identifying both the structure and the unknown parameters of complex number systems. A forward regression procedure is proposed as an optimal search algorithm for this problem. Simulated examples which show the application of the method to the parameterization of linear frequency response functions are included. Magnitudes of the estimated orthogonal parameters can be used to indicate whether complex variables are related to the system. Combining the modified error reduction test with orthogonal parameter value checking forms a very powerful sorting tool which can drastically reduce computational time. Other advantages are that the estimate itself provides information on the goodness of fit of the estimate and implementation on a microprocessor should be straightforward. ESA

**N93-18570*#** Washington Univ., Seattle. Dept. of Computer Science.
**FORMULATION AND ERROR ANALYSIS FOR A GENERALIZED IMAGE POINT CORRESPONDENCE ALGORITHM**
Linda Shapiro, ed., Azriel Rosenfeld, ed. (Maryland Univ., College Park.), Sunil Fotedar (McDonnell-Douglas Corp., Houston, TX.), Rui J. P. deFigueiredo (California Univ., Irvine.), and Kumar Krishen (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.) San Diego, CA Academic Press, Inc. 1992 17 p Repr. from Computer Vision and Image Processing, 1992 p 593-607
(Contracts NAS9-17145; NCC9-16)
(NASA-CR-192005; NAS 1.26:192005; LC-91-29657; ISBN-0-12-638660-9)
Avail: CASI HC A03/MF A01

A Generalized Image Point Correspondence (GIPC) algorithm, which enables the determination of 3-D motion parameters of an object in a configuration where both the object and the camera are moving, is discussed. A detailed error analysis of this algorithm has been carried out. Furthermore, the algorithm was tested on both simulated and video-acquired data, and its accuracy was determined. Author

**N93-18574#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.
**TOWARDS A META SIMPLIFIER [VERS UN META SIMPLIFICATEUR]**
Christele Faure (Nice Univ., France ) Apr. 1991 15 p
(INRIA-RR-1402; ETN-93-92634) Avail: CASI HC A03/MF A01

A general approach to simplification in a computer algebra system is described. In distributed computer algebra systems, the simplification process modifies each input expression to fit a certain definition of 'simplicity'. This definition is given (through the written simplifier) by the system designer and not by the user. However, this definition may not correspond to the user's notion of simplicity. Simplifiers are considered to be uncustomizable as far as the simplification knowledge is encoded in the simplification functions. A model of simplifier divided in two parts is presented: the 'base' that contains all the knowledge and the 'engine' which really computes simplification. Two basic kinds of knowledge (equations, evaluation functions), and their two associated processes are described. Since a simplifier is always connected to a system, an attempt to define the interactions between a simplifier and a host system is made. ESA

**N93-18575#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.

**AN IMPERATIVE LANGUAGE FOR TASK-LEVEL PROGRAMMING: DEFINITION IN TEMPORAL LOGICS [UN LANGAGE IMPERATIF DE PROGRAMMATION AU NIVEAU TACHE: DEFINITION EN LOGIQUE TEMPORELLE]**

Eric Rutten and Lionel Marce (Universite de Bretagne Occidentale, Brest, France ) Apr. 1991 23 p In FRENCH Sponsored in part by European Research Consortium in Informatics and Mathematics; CNR; Center for Mathematics and Computer Science; GMD; INESC; and Sciences Research Council

(INRIA-RR-1406; ETN-93-92635) Avail: CASI HC A03/MF A01

A logical and temporal model of plans of action, provided with an imperative control structure, is proposed. A set of imperative control primitives that define the temporal arrangement of the actions and subplans within their scope is defined on the basis of an interval based temporal logic. Primitives for the reaction to evolutions in the environment are then defined in the same formalism, in order to respond to constraints concerning interaction and adaptation to the external world in the application domain of robotics. ESA

**N93-18610#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.

**TASK-LEVEL ROBOT PROGRAMMING COMBINING OBJECT-ORIENTED DESIGN AND SYNCHRONOUS APPROACH: A TENTATIVE STUDY [PROGRAMMATION AU NIVEAU TACHE EN ROBOTIQUE ASSOCIANT UNE MODELISATION OBJET ET UNE APPROCHE SYNCHRONE: UNE ETUDE PRELIMINAIRE]**

Eve Coste-Maniere (Ecole Nationale Superieure des Mines, Valbonne, France), Bernard Espiau (Ecole Nationale Superieure des Mines, Valbonne, France), and Eric Rutten Jun. 1991 109 p

(INRIA-RR-1441; ETN-93-92648) Avail: CASI HC A06/MF A02

An approach to the design of elementary robot actions and to the programming of applications is presented. The three basic features of the proposed methodology are as follows: the choice of the synchronous language ESTEREL as the unique way of expression, at the 'local' level as well as at the application level, in order to ensure a coherent code generation associated with a global automaton; an object-oriented design of all entities which constitute a robot task, aimed at the further achievement of an efficient man machine interface; and a high level application description through a plan which allows easy specification of logical and temporal relations between robot tasks while avoiding the end user writing any ESTEREL code. The models used, with focus on the object called 'robot task', are described. This is indeed a kind of elementary robot action which implements a dedicated control scheme and is provided with its own ESTEREL coded behavior. A prototype of an application programming language is presented and its translation into ESTEREL is described. Three examples in the area of manufacturing robotics are examined. ESA

**N93-18613#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.

**FLOW MODELS OF DISTRIBUTED COMPUTATIONS: THREE EQUIVALENT SEMANTICS FOR CCS [TROIS SEMANTIQUES EQUIVALENTES POUR CSS]**

Gerard Boudol and Ilaria Castellani Jul. 1991 56 p Sponsored in part by Commission of the European Communities

(INRIA-RR-1484; ETN-93-92655) Avail: CASI HC A04/MF A01

Three notions of computation for processes described as CCS (Calculus of Communicating Systems) terms are introduced. The first uses an adaptation of the equivalence by perturbations. In this setting, a computation is an equivalence class of sequences of transitions, up to the permutation of independent steps. The second notion of computation is given by means of an interpretation of CCS into a new class of event structures, the flow event structures. This can be seen as a reformulation of Winskel semantics for CCS by means of stable event structures. Here a computation is a configuration of an event structure. The third notion of computation is determined by an interpretation of CCS terms as Petri nets, more precisely as flow nets. Here a computation is a set of events that are firable in sequence in the net. These three computational interpretations of CCS are shown to coincide in the sense that for a given term, the three domains of computations are isomorphic. To this end, an intermediary transition system for CCS, where the past is recorded, is used; this appears to be a system of 'trace computations', which provides another means to define the same abstract domain of computations. ESA

**N93-18630#** Technische Univ., Brunswick (Germany). Fakultaet fuer Maschinenbau und Elektrotechnik.

**REALIZATION OF REAL TIME GRAPHICS IN VEHICLES WITH HIGH DYNAMIC MOTION Ph.D. Thesis [EIN BEITRAG ZUR REALISIERUNG VON ECHTZEIT-GRAPHIK IN FAHRZEUGEN MIT HOCHDYNAMISCHER BEWEGUNG]**

Klaus Bavendiek 1991 122 p In GERMAN

(ETN-93-92739) Avail: CASI HC A06/MF A02

A process to make interactive computer graphics more comfortable and fast for cockpit indicator systems, which allows the image representations to be programmed in a high level language with the use of the work station, is developed. Human visual acuity was examined to establish the image quality and dynamics requirements. For both onboard and ground vector oriented graphic systems the T800 transputer was chosen as a microprocessor to realize parallel data processing. A digital scanning pulse generator was used for conversion of images into corresponding voltages of the electrical flight instrument system, which computes the display lines with the Bresenham algorithm. The necessary memory capacity was achieved by means of several powerful arithmetic logic units connected in series following a pipeline concept. A real time simulation was written for an experimental aircraft and tested for a static image project from a computer aided design system. ESA

**N93-18649#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.

**A HARDWARE IMPLEMENTATION OF PURE ESTEREL [UNE IMPLANTATION MATERIELLE D'ESTEREL PUR]**

Gerard Berry (Ecole Nationale Superieure des Mines, Valbonne, France ) Jul. 1991 41 p Presented at Workshop on Formal Methods in VLSI, Miami, FL, Jan. 1991; sponsored in part by Digital Equipment

(INRIA-RR-1479; ETN-93-92652) Avail: CASI HC A03/MF A01

A hardware implementation of the pure synchronization subset of the ESTEREL language is presented. ESTEREL is a synchronous concurrent programming language dedicated to reactive systems (controllers, protocols, man machine interfaces, etc.). ESTEREL has an efficient standard software implementation based on well defined mathematical semantics. Each program of the implementation generates a specific circuit that responds to any input in one clock cycle. When the source program satisfies some statically checkable dynamic properties, the circuit is shown to be semantically equivalent to the source program. The hardware translation is effectively implemented on the programmable active memory Perle0. ESA

**N93-18650#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.

**A STATIC VIEW OF LOCALITIES [SUR LES PROCESSUS STATIQUEMENT REPARTIS]**

Luca Aceto Jul. 1991 36 p

(INRIA-RR-1483; ETN-93-92654) Avail: CASI HC A03/MF A01

Alternative effective characterizations for nets of automata of the location

equivalence and preorder recently introduced by Boudol et al are proposed. Contrary to the technical development in the above, where locations are dynamically associated to the subparts of a process in the operational semantics, the equivalence and preorder proposed are based on a static association of locations to the parallel components of a net. Following this status approach, it is possible to give these 'distributed nets' a standard operational semantics which associates with each net a finite labelled transition system. Using this operational semantics for distributed nets, effective notions of equivalence and preorder are introduced which are shown to coincide with those proposed by Boudol et al. ESA

**N93-18651#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.

**THE ESTEREL LANGUAGE [LE LANGAGE ESTEREL]**

Frederic Boussinot (Ecole Nationale Superieure des Mines, Valbonne, France) and Robert deSimone Jul. 1991 27 p

(INRIA-RR-1487; ETN-93-92657) Avail: CASI HC A03/MF A01

The basics of the ESTEREL model of reactive synchronous parallel systems are presented. The ESTEREL programming style, based on 'instantaneous communications and decisions', is illustrated through the example of a mouse handler. The ESTEREL formal semantics are described and the compilation of programs into finite states sequential machines for efficient execution is shown. The current implementation is described together with the ESTEREL environment, including simulation, verification, and validation tools. ESTEREL experiments are reported in various contexts. ESA

**N93-18698#** Technical Research Centre of Finland, Espoo. Ship Lab.

**MOTION SIMULATION OF UNDERWATER VEHICLES**

Seppo Kalske Apr. 1992 168 p Sponsored in part by Hollming Ltd.; Masa-Yards Ltd.; and Repola Ltd.

(VTT-Pubs-97; ISBN-951-38-4075-1; ETN-93-93073) Copyright Avail: CASI HC A08/MF A02

A three dimensional time domain simulation method for tethered subsea vehicle motions was developed. The method is applicable to vehicles equipped with thrusters as propulsion devices, and can be applied to vehicles of arbitrary shape. A computer program using the present method was written and is described in detail. Results are presented for one Remotely Operated Vehicle (ROV) with comparison of measured results from maneuvering tests in horizontal and vertical planes in a towing tank. The agreement between simulated and measured results is good in most cases. The effects of various input data quantities and differing thruster configurations were studied in additional simulations. ESA

**N93-18775*#** California Univ., Los Angeles.

**ON RECURSIVE LEAST-SQUARES FILTERING ALGORITHMS AND IMPLEMENTATIONS Ph.D. Thesis**

Shih-Fu Hsieh 1990 149 p

(Grants NAG2-374; NSF NCR-88-14407)

(NASA-CR-191396; NAS 1.26:191396) Copyright Avail: CASI HC A07/MF A02

In many real-time signal processing applications, fast and numerically stable algorithms for solving least-squares problems are necessary and important. In particular, under non-stationary conditions, these algorithms must be able to adapt themselves to reflect the changes in the system and take appropriate adjustments to achieve optimum performances. Among existing algorithms, the QR-decomposition (QRD)-based recursive least-squares (RLS) methods have been shown to be useful and effective for adaptive signal processing. In order to increase the speed of processing and achieve high throughput rate, many algorithms are being vectorized and/or pipelined to facilitate high degrees of parallelism. A time-recursive formulation of RLS filtering employing block QRD will be considered first. Several methods, including a new non-continuous windowing scheme based on selectively rejecting contaminated data, were investigated for adaptive processing. Based on systolic triarrays, many other forms of systolic arrays are shown to be capable of implementing different algorithms. Various updating and downdating systolic algorithms and architectures for RLS filtering are examined and compared in details, which include Householder reflector, Gram-Schmidt procedure, and Givens rotation. A unified approach encompassing existing square-root-free algorithms is also proposed. For the sinusoidal spectrum estimation problem, a judicious method of separating the noise from the signal is of great interest. Various truncated QR methods are proposed for this purpose and compared to the truncated SVD method. Computer simulations provided for detailed comparisons show the effectiveness of these methods. This thesis deals with fundamental issues of numerical stability, computational efficiency, adaptivity, and VLSI implementation for the RLS filtering problems. In all, various new and modified algorithms and architectures are proposed and analyzed; the significance of any of the new method depends crucially on specific application. Author

**N93-18847#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**FORMAL DEVELOPMENT OF Ada PROGRAMS USING Z AND ANNA: A CASE STUDY Final Report**

Patrick R. H. Place, William G. Wood, David C. Luckham (Stanford Univ., CA.), Walter Mann (Stanford Univ., CA.), and Sriram Sankar (Stanford Univ., CA.) Feb. 1991 45 p

(Contract F19628-90-C-0003)

(AD-A235698; CMU/SEI-91-TR-1; ESD-TR-91-1) Avail: CASI HC A03/MF A01

This report describes a method for the formal development of Ada programs from a formal specification written in Z. ANNotated Ada (Anna) is used as an intermediate language linking the more abstract Z specifications to the concrete Ada program. The method relies on the notion that successive small transformations of a specification are easier to verify than a few large transformations. Essentially the method uses three notations for the representation of the system: an implementation-independent notation for the specification of the system, an implementation-dependent notation for the representation of a lower level specification of the system, and the implementation language. Z and Anna are outlined briefly, and examples of transformations are presented. A simple Z specifications was chosen, and the transformations presented in the report are transformations of the Z specifications into Anna. Conclusions are drawn about the development method presented. This report describes recent work performed by the formal specifications project of the Software Engineering Institute in conjunction with members of the Anna project at Stanford University. GRA

**N93-18855*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**SYSTEM FOR SIMULTANEOUSLY LOADING PROGRAM TO MASTER COMPUTER MEMORY DEVICES AND CORRESPONDING SLAVE COMPUTER MEMORY DEVICES Patent**

William A. Hall, inventor (to NASA) 16 Feb. 1993 16 p Filed 15 Mar. 1989 Supersedes N90-16411 (28 - 8, p 1108)

(NASA-Case-MSC-21387-1; US-Patent-5,187,794;
US-Patent-Appl-SN-323748; US-Patent-Class-395-800;
US-Patent-Class-364-DIG.1; US-Patent-Class-364-229;
US-Patent-Class-364-240; US-Patent-Class-364-243;
US-Patent-Class-364-187; US-Patent-Class-395-500) Avail: US Patent and Trademark Office

A bus programmable slave module card for use in a computer control system is disclosed which comprises a master computer and one or more slave computer modules interfacing by means of a bus. Each slave module includes its own microprocessor, memory, and control program for acting as a single loop controller. The slave card includes a plurality of memory means (S1, S2...) corresponding to a like plurality of memory devices (C1, C2...) in the master computer, for each slave memory means its own communication lines connectable through the bus with memory communication lines of an associated memory device in the master computer, and a one-way electronic door which is switchable to either a closed condition or a one-way open condition. With the door closed, communication lines between master computer memory (C1, C2...) and slave memory (S1, S2...) are blocked. In the one-way open condition invention, the memory communication lines or each slave memory means (S1, S2...) connect with the memory communication lines of its associated memory device (C1, C2...) in the master computer, and the memory devices (C1, C2...) of the master computer and slave card are electrically parallel such that information seen by the master's memory is also seen by the slave's memory. The slave card is also connectable to a switch for electronically removing the slave microprocessor from the system. With the master computer and the slave card in programming mode relationship, and the slave microprocessor

electronically removed from the system, loading a program in the memory devices (C1, C2...) of the master accomplishes a parallel loading into the memory devices (S1, S2...) of the slave.

Official Gazette of the U.S. Patent and Trademark Office

**N93-18858*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**DYNAMIC PATTERN MATCHER USING INCOMPLETE DATA Patent**

Gordon G. Johnson, inventor (to NASA) and Lui Wang, inventor (to NASA) 23 Feb. 1993 22 p Filed 26 Aug. 1991 Supersedes N92-17860 (30 - 8, p 1344)

(NASA-Case-MSC-21415-1-SB; US-Patent-5,189,709; US-Patent-Appl-SN-749819; US-Patent-Class-382-10; US-Patent-Class-382-30; US-Patent-Class-381-43; Int-Patent-Class-G06K-9/00) Avail: US Patent and Trademark Office

This invention relates generally to pattern matching systems, and more particularly to a method for dynamically adapting the system to enhance the effectiveness of a pattern match. Apparatus and methods for calculating the similarity between patterns are known. There is considerable interest, however, in the storage and retrieval of data, particularly, when the search is called or initiated by incomplete information. For many search algorithms, a query initiating a data search requires exact information, and the data file is searched for an exact match. Inability to find an exact match thus results in a failure of the system or method.

Official Gazette of the U.S. Patent and Trademark Office

**N93-18860*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**SOFTWARE ENGINEERING LABORATORY (SEL) DATABASE ORGANIZATION AND USER'S GUIDE, REVISION 2**

Linda Morusiewicz (Computer Sciences Corp., Greenbelt, MD.) and John Bristow Oct. 1992 244 p

(NASA-TM-108631; NAS 1.15:108631; SEL-89-201-Rev-2) Avail: CASI HC A11/MF A03

The organization of the Software Engineering Laboratory (SEL) database is presented. Included are definitions and detailed descriptions of the database tables and views, the SEL data, and system support data. The mapping from the SEL and system support data to the base table is described. In addition, techniques for accessing the database through the Database Access Manager for the SEL (DAMSEL) system and via the ORACLE structured query language (SQL) are discussed. Author

**N93-18861*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**RECOMMENDED APPROACH TO SOFTWARE DEVELOPMENT, REVISION 3**

Linda Landis (Computer Sciences Corp., Greenbelt, MD.), Sharon Waligora (Computer Sciences Corp., Greenbelt, MD.), Frank McGarry, Rose Pajerski, Mike Stark, Kevin Orlin Johnson (Computer Sciences Corp., Greenbelt, MD.), and Donna Cover (Computer Sciences Corp., Greenbelt, MD.) Jun. 1992 226 p

(NASA-TM-108630; NAS 1.15:108630; SEL-81-305-Rev-3) Avail: CASI HC A11/MF A03

Guidelines for an organized, disciplined approach to software development that is based on studies conducted by the Software Engineering Laboratory (SEL) since 1976 are presented. It describes methods and practices for each phase of a software development life cycle that starts with requirements definition and ends with acceptance testing. For each defined life cycle phase, guidelines for the development process and its management, and for the products produced and their reviews are presented. Author

**N93-18867#** California Univ., Berkeley. Lawrence Berkeley Lab.

**THE USE OF GEOMETRIC PRIOR INFORMATION IN BAYESIAN TOMOGRAPHIC IMAGE RECONSTRUCTION: A PRELIMINARY REPORT**

J. Lacer, B. M. terHaarRomeny, and M. A. Viergever (University Hospital, Utrecht, Netherlands ) Jun. 1992 15 p Presented at the Society of Photo-Optical Instrumentation Engineers (SPIE) Mathematical Methods in Medical Imaging, San Diego, CA, 22-23 Jul. 1992

(Contract DE-AC03-76SF-00098)

(DE92-041215; LBL-32488; CONF-9207152-1) Avail: CASI HC A03/MF A01

In this paper we examine the possibility of using pure geometrical information from a prior image to assist in the reconstruction of tomographic data sets with lower number of counts. The situation can arise in dynamic studies, for example, in which the sum image from a number of time frames is available, defining desired regions-of-interest (ROI's) with good accuracy, and the time evolution of uptake in those ROI's needs to be obtained from the low count individual data sets. 'the prior information must be purely geometrical in such a case, so that the activity in the ROI's of the prior does not influence the estimated uptake from the individual time frames. It is also desired that the prior does not impose any other conditions on the reconstructions, i.e., no smoothness or deviation from a known set of values is desired. We attack this problem in the framework of Vision Response Functions (VRF's), based on the work done by J.J. Koenderink in Utrecht. We show that there are assemblies of VRF's that can be presented in a form that is invariant with respect to rotations and translations, and that some functions of those invariants can convey the desired geometric prior information independent of the level of activity in the ROI'S, except at very low levels. DOE

**N93-18874*#** Computer Sciences Corp., Hampton, VA.

**VGRIDSG: AN UNSTRUCTURED SURFACE GRID GENERATION PROGRAM**

Michael J. Bockelie Jan. 1993 15 p

(Contract NAS1-19038; RTOP 505-90-53-02)

(NASA-CR-191426; NAS 1.26:191426; TAO-60291) Avail: CASI HC A03/MF A01

This report contains an overview of the VGRIDSG unstructured surface grid generation program. The VGRIDSG program was created from the VGRID3D unstructured grid generation program developed by Vigyan, Inc. The purpose of this report is to document the changes from the original VGRID3D program and to describe the capabilities of the new program.

Author

**N93-18948#** Naval Postgraduate School, Monterey, CA. Dept. of Computer Science.

**A MODEL FOR MERGING SOFTWARE PROTOTYPES**

David A. Dampier 23 Sep. 1992 19 p

(AD-A258781; NPS-CS-92-014) Avail: CASI HC A03/MF A01

As software becomes more complex, more sophisticated development and maintenance methods are needed to ensure software quality. Computer Aided Prototyping achieves this via quickly built and iteratively updated prototypes of the intended system. This process requires automated support for keeping track of many independent changes and for exploring different combinations of alternative changes and refinements. This paper formalizes the update/change merging process and extends the idea to multiple changes to the same base prototype. Applications of this technology include: automatic updating of different versions of existing software with changes made to the baseline version of the system; integrating changes made by different design teams during development; and checking consistency after integration of seemingly disjoint changes to the same software system.

GRA

**N93-19016#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**CREATING AND MANIPULATING A DOMAIN-SPECIFIC FORMAL OBJECT BASE TO SUPPORT A DOMAIN-ORIENTED APPLICATION COMPOSITION SYSTEM M.S. Thesis**

Mary A. Randour Dec. 1992 214 p

(AD-A259018; AFIT/GCS/ENG/92D-13) Avail: CASI HC A10/MF A03

This research investigated technology which enables sophisticated users to specify, generate, and maintain application software in domain-oriented terms. To realize this new technology, a development environment, called Architect, was designed and implemented. Using canonical formal specifications of domain objects, Architect rapidly composes these specifications into a software application and executes a prototype of that application as a means to demonstrate its correctness before any programming language specific code is generated. This thesis investigated populating and manipulating the formal object base required by Architect. This object base is built using a domain-specific language (DSL) which serves as an interface between the user and a domain model. The domain model describes primitive domain object classes and composition rules and is formalized via a domain modeling language. The packaging of the

objects into components is defined by an architecture model which was part of a separate thesis. The Software Refinery environment was used to develop a methodology for defining DSLs for Architect and for manipulating the resulting populated object base. GRA

**N93-19062#** Naval Postgraduate School, Monterey, CA. Dept. of Administrative Sciences.
**A CLEARINGHOUSE FOR SOFTWARE REUSE: LESSONS LEARNED FROM RAPID/DSRS INITIATIVES Technical Report, period ending 1992**
Tung Bui, James C. Emerg, Gerald Harms, Tina VanHook, and Myung Suh Oct. 1992 48 p
(Contract MIPR-DXAM20001)
(AD-A258782; NPS-AS-93-006) Avail: CASI HC A03/MF A01

This study reports the lessons learned from the recent establishment of the Defense Software Repository Service (DSRS) to provide government agencies and authorized contractors with reusable software components (RSC's). DSRS is based on a pilot operation initiated by the Army's Reusable Ada Product for Information System Development (RAPID). The study concludes that a clearinghouse is a necessary condition for software reuse in DoD. To become a software productivity multiplier, the clearinghouse must populate its repository with quality RSC's, and incentives for reuse must originate from high-level DoD management. GRA

**N93-19065#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**X-AAARF: AN X WINDOW BASED VERSION OF THE AFIT ALGORITHM ANIMATION RESEARCH FACILITY M.S. Thesis**
Charles R. Wright, Jr. Dec. 1992 113 p
(AD-A258832; AFIT/GCS/ENG/92D-22) Avail: CASI HC A06/MF A02

The AFIT Algorithm Animation Research Facility was developed by the Air Force Institute of Technology (AFIT) as a teaching aid for data structures and algorithm design of sequential processes. However, AAARF's unique design makes it particularly suitable for the animation of algorithms running on remote systems. In particular, an extensive set of parallel performance animations has been developed for the Intel iPSC/2 Hypercube for parallel program analysis and performance optimization. The AAARF system was originally developed using the Sun Microsystems' SunView(TM) windowing system. Recent advances in Graphical User Interface (GUI) technology combined with Sun's adoption of the X Window System as their workstation window environment, has necessitated the replacement of AAARF's GUI with a modern, X-based user interface. The GUI replacement process, starting with selecting a GUI toolkit, designing and implementing the new user interface, testing, and finally the results of implementing the new user interface is described. Also included is a discussion of several changes/enhancements to AAARF which were necessary before the GUI replacement process began. GRA

**N93-19081#** Institute for Defense Analyses, Alexandria, VA.
**INTERACTIVE OBJECT-ORIENTED DISPLAY TECHNOLOGIES: A STUDY OF TWO CD-ROM-BASED DMA PRODUCTS**
Robert J. Atwell and D. G. McBryde Sep. 1992 25 p
(AD-A258896; IDA-D-1216; IDA/HQ-92-42622; AD-E501596) Avail: CASI HC A03/MF A01

This integration of standardized full color maps into technical reports and computer software was a complex and time consuming process. This work reports on the use of two readily available Defense Mapping Agency ARC Digitized Raster Graphics (ADRG) and Digital Chart of the World (DCW) product lines that can greatly facilitate this process. The report includes samples of these maps and includes as an addendum several computer disks for use with these products. GRA

**N93-19083#** Software Productivity Consortium, Herndon, VA.
**SOFTWARE MEASUREMENT GUIDEBOOK, VERSION 02.00.02**
Robert Cruickshank, Henry Felber, John Gaffney, and Richard Werling Dec. 1992 234 p
(Contract MDA972-92-J-1018)
(AD-A258961; SPC-91060-CMC) Avail: CASI HC A11/MF A03

The Software Measurement Guidebook, Version 2.0, provides practical guidance for the quantitative management of a software development project. It describes how to use measurement methods in setting quantifiable goals for a software project, in selecting metrics to support those goals, and in managing to meet those goals. It presents methods for estimating software size, cost, and development schedule. It provides tracking and monitoring methods to evaluate status and earned value for ongoing development projects and to help ensure that the software projects proceed as planned and that any deviations from the plan are detected and quickly corrected. It also presents methods to estimate the costs of support to software development. GRA

**N93-19085#** Software Productivity Consortium, Herndon, VA.
**PROCESS ENGINEERING WITH THE EVOLUTIONARY SPIRAL PROCESS MODEL, VERSION 01.00.01**
Robert Cruickshank, John Gaffney, and Richard Werling Dec. 1992 223 p
(Contract MDA972-92-J-1018)
(AD-A258966; SPC-92079-CMC) Avail: CASI HC A10/MF A03

This report describes how the Evolutionary Spiral Process (ESP) model can be used to define and perform a software development process for a specific project. Although it is tempting to think that a software development process can be reused, without change, across projects within an organization, the reality facing most projects is that unique influencing characteristics, or process drivers, may result in software development processes which vary slightly to significantly across projects. The ESP model is an adaptation of the basic spiral model. The ESP model explicitly recognizes project management activities missing from traditional software development process models and emphasizes risk management, or the ability to anticipate and respond quickly to faults such as problems or deviations from project plans. In addition, the ESP model supports evolutionary process engineering by allowing a project to engineer its process dynamically through defining, instantiating, enacting, and evolving its process definition. Because of these features, the ESP model provides the flexibility to identify and address project-specific process drivers continually and to evolve the software development process accordingly. The intent of this technical report is to explain how a project-specific software development process can be engineered using the ESP model. GRA

**N93-19086#** Software Productivity Consortium, Herndon, VA.
**PROCESS DEFINITION AND MODELING GUIDEBOOK, VERSION 01.00.02**
Richard Bechtold Dec. 1992 379 p
(Contract MDA972-92-J-1018)
(AD-A258967; SPC-92041-CMC) Avail: CASI HC A17/MF A03

This guidebook is not intended to advance the state of the art. It does, however, use state of the art principles as a means for advancing the state of the practice. The Consortium's objective with this version of the guidebook is to provide sufficient tools, techniques, guidelines, and examples to enable you to acquire the necessary understanding and skills to capably perform process representation. It must be emphasized that a deliberate attempt was made to stay with fundamental principles and techniques that can be easily learned and readily applied. The Consortium is actively interested in end-user reaction, case studies, feedback, and any suggestions or recommendations you have for improving and advancing the content of this guidebook. While insights from researchers and technologists are also appreciated, this guidebook is designed to provide information useful to process project managers, process line engineers, and others whose daily activities are consistently constrained by crowded schedules and tight budget considerations. It is from this audience that the Consortium is especially interested in feedback. GRA

**N93-19334#** Carnegie-Mellon Univ., Pittsburgh, PA.
**REAL-TIME FAULT TOLERANT COMPUTER SYSTEMS Annual Report, 1 Apr. - 30 Sep. 1992**
John Lehoczky, Lui Sha, Marc Bodson, and Ragunathan Rajkumar 30 Sep. 1992 8 p
(Contract N00014-92-J-1524)
(AD-A258891) Avail: CASI HC A02/MF A01

This research project is developing a new approach to software fault tolerance called analytic redundancy. It has been widely acknowledged that software failures are the most important issue in large computer system reliability. The failure rate of software has risen to 9.4 times the failure rate of hardware, and software failures have captured substantial media attention in recent years. The problem of software reliability is especially difficult because the major recognized approaches (recovery blocks and

n-version programming) are known to have serious drawbacks. Analytic redundance is an approach which uses simplicity (in the form of software which is relatively simple, well understood and well tested but whose performance is merely adequate) to control complexity (in the form of software which has high performance but is complex and, therefore, not reliable). Rather than trying to combine the two algorithms (which would create an even less reliable system), we allow the complex software to control the system as long as it is behaving properly (as judged by the simple software). If it is determined that the complex software is behaving incorrectly, then the simple software takes over. The simple software will guarantee a baseline, if not optimal, performance. GRA

**N93-19335#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**CREATING AND MANIPULATING FORMALIZED SOFTWARE ARCHITECTURES TO SUPPORT A DOMAIN-ORIENTED APPLICATION COMPOSITION SYSTEM M.S. Thesis**

Cynthia G. Anderson Dec. 1992 256 p

(AD-A258900; AFIT/GCS/ENG/92D-01) Avail: CASI HC A12/MF A03

This research investigated technology which enables sophisticated users to specify, generate, and maintain application software in domain-oriented terms. To realize this new technology, a development environment, called Architect, was designed and implemented. Using canonical formal specifications of domain objects, Architect rapidly composes these specifications into a software application and executes a prototype of that application as a means to demonstrate its correctness before any programming language specific code is generated. Architect depends upon the existence of a formal object base (or domain model) which was investigated by another student in related research. The research described in this thesis relied on the concept of a software architecture, which was a key to Architect's successful implementation. Various software architectures were evaluated and the Object-Connection-Update (OCU) model, developed by the Software Engineering Institute, was selected. The Software Refinery environment was used to implement the composition process which encompasses connecting specified domain objects into a composed application, performing semantic analysis on the composed application, and, if no errors are discovered, simulating the execution of the application. Architect was validated using both artificial and realistic domains and was found to be a solid foundation upon which to build a full-scale application composition system. GRA

**N93-19337#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**ANALYSIS OF KRIGING APPLIED TO RESOLUTION ENHANCEMENT OF DIGITAL SATELLITE IMAGERY M.S. Thesis**

David J. Blaufuss 1 Dec. 1992 139 p

(AD-A258914; AFIT/GSO/ENS/92D-3) Avail: CASI HC A07/MF A02

To aid the viewer in interpreting the information contained in an image, spatial resolution of the image can be increased. One way to increase the resolution is to improve the optics and sensors of the imaging system. Another is to process the data on the ground by computer. Enhancement techniques can be employed to alter the image and extract necessary data. Current techniques to manipulate and enlarge an image are nearest-neighbor, bilinear interpolation, and cubic convolution which can give greater clarity and readability. To satisfy the growing demand for quality (high-resolution) remotely sensed images, new techniques to enhance images need to be developed. Kriging is the geostatistical spatial estimation technique developed by Matheron that optimally predicts spatial data using observations at nearby locations. This research investigates the application of kriging as a technique of digital image resolution enhancement by adapting its use for the personnel computer and validating its capability and reliability. Twenty-seven percent of the images tested produced significantly lower means for kriging than cubic convolution with 45 percent of the kriged images producing lower variances. GRA

**N93-19338#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A MODEL FOR DETERMINING TASK SET SCHEDULABILITY IN THE PRESENCE OF SYSTEM EFFECTS M.S. Thesis**

Rusty O. Baldwin Dec. 1992 261 p

(AD-A258915; AFIT/GCS/ENG/92D-02) Avail: CASI HC A12/MF A03

This research developed a parameterized model that accounts for system overhead and determines when an Ada runtime environment can no longer successfully execute a given Ada task set and still meet all deadlines. The Ada Compiler Evaluation Capability benchmark was used to characterize an actual runtime environment. Using that data, a generic model of a preemptive, rate monotonic priority based runtime system was developed which accounts for overhead due to clock updates, context switching, task suspension, and synchronization. Validation was based on the Hartstone benchmark. First, the benchmark was executed using, the actual runtime environment. Then, those results were compared with the execution of the benchmark using the model. In all cases, except one, the model predicted the point where the task set would fail. A runtime system optimization omitted from model caused the single failure. Experiments conducted using the model allowed the demonstration of the following results. System overhead can be modeled within the existing framework of rate monotonic scheduling theory. Runtime optimizations can be extremely sensitive to phase relationships between task periods and workloads and can render a schedulable task set unschedulable. Requirements of the task set and the performance of the runtime system must be considered simultaneously. GRA

**N93-19343#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**EXAMINING A LAYERED APPROACH TO FUNCTION AND DESIGN REPRESENTATION FOR REUSABLE SOFTWARE COMPONENTS M.S. Thesis**

Paul D. Siebels Dec. 1992 115 p

(AD-A258920; AFIT/GCE/ENG/92D-11) Avail: CASI HC A06/MF A02

This effort examined ways to improve the effectiveness of reusable software libraries. The main area of investigation was in improving the user interface by finding better ways to present the software components to potential re-users. The first aspect which was considered was finding an effective representation for reusable software components. A set of criteria was developed for evaluating the effectiveness of software representations. The criteria consisted of generality, expressiveness, understandability, consistency, and resolution. The second aspect which was considered was how to present the software component information to the user to facilitate finding the appropriate component for reuse. A representation framework was examined which advocated presenting reuse information in four layers: component functionality, design information, quality metrics, and source code. Several current representations for software function and design were evaluated using the criteria listed above. The highest rated representations were then incorporated into a prototype library interface for examination by a group of software engineers. Feedback was collected and summarized in a set of recommendations and conclusions. GRA

**N93-19352#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**METHODS FOR VIEWING RADAR CROSS SECTION DATA IN THREE DIMENSIONS M.S. Thesis**

David J. Tisdale Dec. 1992 67 p

(AD-A258905; AFIT/GCS/ENG/92D-18) Avail: CASI HC A04/MF A01

Radar Cross Section data is an important factor in the design of modern fighter and bomber aircraft. Minimization of the reflected radar energy is one of the key issues when choosing shapes and materials in new aircraft. Visualization of the energy scattered back to a radar is neither intuitive nor easy. The mission planner and pilot need to gain an understanding of the vulnerabilities inherent in the design of the systems they use. The advent of relatively low cost graphics workstations has made their use affordable in applications inconceivable only a few short years ago. This thesis examines three graphics rendering techniques and their applicability to the display of three-dimensional radar cross section data. This study looks at three tools, PSR, a particle system renderer; the Satellite Modeler, a three-dimensional surface renderer; and VIPER, a volumetric renderer for their applicability, utility, and ease of use in the display of radar cross section data. Each of the systems was tested using the same data set, and the results compared later in this treatise. Although the purpose of this study is to determine the applicability of different techniques, the results can be used to further develop fast, efficient rendering systems for the visualization of radar cross section data. GRA

**N93-19355#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**SPECTRAL AND SPATIAL PATTERN RECOGNITION IN DIGITAL IMAGERY M.S. Thesis**

John M. Amrine Dec. 1992 346 p

(AD-A258910; AFIT/GSO/ENS/92D-01) Avail: CASI HC A15/MF A03

The main purpose of this research is to develop a model that can be used to solve combined spectral and spatial pattern recognition problems. The basis of my model is a multiobjective discrete programming model developed by Benabdullah and Wright (B and W). The model will be modified and then tested by solving a real world problem with SPOT multispectral imagery. Several improvements were added to the B and W model, namely standard border length accounting and control over which pixels are selected by the model. The model was also improved to process more than one channel of imagery at a time. The model was successful in locating a user specified target, but this was not possible with all SPOT channel combinations. The Channel 2-3 combination caused the program to abort after 5,000 iterations. Three improvements are still required. An ADBASE formulation would automatically try all the different lambda weights and thus find all the noninferior solutions. Another improvement is to reformulate the problem as a network with side constraints problem. This would ensure integer solutions and quicker results. The final improvement is the creation of an objective function that selects the most representative pixels of a particular land type. GRA

**N93-19442#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**FORMALIZATION AND TRANSFORMATION OF INFORMAL ANALYSIS MODELS INTO EXECUTIVE REFINE (TM) SPECIFICATIONS M.S. Thesis**

Mary M. Boom and Bradley D. Mallare Dec. 1992 352 p

(AD-A258901; AFIT/GCS/ENG/92D-04) Avail: CASI HC A16/MF A03

This research developed and implemented an automated technique for translating informal specifications into formal, executable specifications. A Unified Abstract Model (UAM) was developed to combine the information contained in Entity Relationship, State Transition, and Data Flow Models into a concise, object-based representation. The UAM forms the basis for defining a formal language, the Object Modeling Language (OML), used to capture the information contained in the UAM. By using OML, we were able to develop an automated translation process to convert informal specifications into executable, formal specifications. The Software Refinery Development Environment enabled us to easily develop a parser that translates an OML specification into an abstract syntax tree. A Translation Executive transforms the information contained in the abstract syntax tree into an executable, REFINE specification. The specifier can quickly validate the correctness of the informal specification by testing its behavior. Additionally, the automatically generated executable specification serves as a basis for formal software design and future development. Two examples, a home heating system and a library database, were used to validate this formalization and transformation process. Our results clearly show the complementary nature of informal and formal methods, and provides a significant step towards formalizing the software development process. GRA

**N93-19448#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**ISSUES IN REQUIREMENTS ELICITATION Final Report**

Michael G. Christel and Kyo C. Kang Sep. 1992 76 p

(Contract F19628-90-C-0003)

(AD-A258932; CMU/SEI-92-TR-12; ESC-TR-92-012) Avail: CASI HC A05/MF A01

There are many problems associated with requirements engineering, including problems in defining the system scope, problems in fostering understanding among the different communities affected by the development of a given system, and problems in dealing with the volatile nature of requirements. These problems may lead to poor requirements and the cancellation of system development, or else the development of a system that is later judged unsatisfactory or unacceptable, has high maintenance costs, or undergoes frequent changes. By improving requirements elicitation, the requirements engineering process can be improved, resulting in enhanced system requirements and potentially a much better system. Requirements engineering can be decomposed into the activities of requirements elicitation, specification, and validation. Most of the requirements techniques and tools today focus on specification, i.e., the representation of the requirements. This report concentrates instead on elicitation concerns, those problems with requirements engineering that are not adequately addressed by specification techniques. An elicitation methodology is proposed to handle these concerns. This new elicitation methodology strives to incorporate the advantages of existing elicitation techniques while comprehensively addressing the activities performed during requirements elicitation. These activities include fact-finding, requirements gathering, evaluation and rationalization, prioritization, and integration. Taken by themselves, existing elicitation techniques are lacking in one or more of these areas. GRA

**N93-19512#** Oak Ridge National Lab., TN.

**HMODEL: AN X TOOL FOR GLOBAL MODEL SEARCH**

G. Ostrouchov 1992 7 p Presented at the 10th Symposium on Computational Statistics, Neuchatel, Switzerland, 23-28 Aug. 1992

(Contract DE-AC05-84OR-21400)

(DE93-002826; CONF-9208176-1) Avail: CASI HC A02/MF A01

HModel is a global model search tool that has X window graphics capability. The user defines the largest generalized polynomial model to consider, HModel generates the collection of all smaller hierarchical models that it contains and displays a graphical representation of the collection. Then, given a model optimality criterion threshold HModel finds all models that are at least as good. That is, HModel classifies all models into two groups: those at or below the threshold and those above the threshold. If the set of models at least as good as the threshold is small, finding this set requires fitting only a small fraction of all models. The selection of models to fit can be automatic or conveniently controlled by the user. A search string facility for selecting sets of models as well as other set operations are also available. All of these functions interact with the graphical representation of the collection of models. The current implementation and this paper focus on log-linear models for categorical data and the Akaike and Bayes information criteria although the underlying ideas are more general. The search can manipulate a collection of up to about 200,000 models on a high performance workstation. For example, six categorical variables give 140.035 possible models of order three or less. DOE

**N93-19633#** Stanford Linear Accelerator Center, CA.

**HIPPODRAW**

M. F. Gravina, P. F. Kunz, and P. E. Rensing Sep. 1992 4 p Presented at the 10th Conference on Computing in High Energy Physics, Annecy, France, 21-25 Sep. 1992

(Contract DE-AC03-76SF-00515)

(DE93-004005; SU-SLAC-PUB-5922; CONF-920966-6) Avail: CASI HC A01/MF A01

HippoDraw is a NeXTSTEP application for viewing statistical data. It has several unique features which make viewing data distributions highly interactive. It also incorporates a set of simple drawing tools. HippoDraw is written in Objective-C and uses the Hippoplotamus library package to handle the n-tuples and displays. DOE

**N93-19744#** Fermi National Accelerator Lab., Batavia, IL.

**SOFTWARE FOR PARALLEL PROCESSING APPLICATIONS**

S. Wolbers Oct. 1992 7 p Presented at the 10th Conference on Computing in High Energy Physics, Annecy, France, 21-25 Sep. 1992

(Contract DE-AC02-76CH-03000)

(DE93-002510; FNAL/C-92/260; CONF-920966-9) Avail: CASI HC A02/MF A01

Parallel computing has been used to solve large computing problems in high-energy physics. Typical problems include offline event reconstruction, Monte Carlo event-generation and reconstruction, and lattice QCD calculations. Fermilab has extensive experience in parallel computing using CPS (cooperative processes software) and networked UNIX workstations for the loosely-coupled problems of event reconstruction and Monte Carlo generation and CANOPY and ACPMAPS for Lattice QCD. Both systems will be discussed. Parallel software has been developed by many other groups, both commercial and research-oriented. Examples include PVM, Express and network-Linda for workstation clusters, and PCN and STRAND88 for more tightly-coupled machines. DOE

**N93-19786#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**USE OF THE MICROCOMPUTER TO SOLVE LARGE P-MEDIAN PROBLEMS [USO DE MICROCOMPUTADOR NA RESOLUCAO DE GRANDES PROBLEMAS DE P-MEDIANAS]**
Luiz Antonio Nogueir Lorena, Hilcea Ferreira Marengoni, and Edson Luiz Franca Senne Aug. 1991 20 p In PORTUGESE
(INPE-5336-PRE/1735) Avail: CASI HC A03/MF A01

The p-median problem was solved in an exact form for problems having up to 900 vertices using a Cray-1S computer. We present a microcomputer implementation for solving large problems within reasonable times. The tree search algorithm combines classical Lagrangean relaxation and subgradient optimization with some performance improvements.
Transl. by FLS

**N93-19847#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN OBJECT-ORIENTED COMPUTER AIDED DESIGN PROGRAM FOR TRADITIONAL CONTROL SYSTEMS ANALYSIS M.S. Thesis**
Wayne E. Bell Dec. 1992 322 p
(AD-A259231; AFIT/GE/ENG/92D-03) Avail: CASI HC A14/MF A03

This thesis is a continuation of the ICECAP-PC research project conducted under Prof. Gary B. Lamont at the Air Force Institute of Technology. It is an ongoing development of a public domain Computer Aided Design package for Control Engineering and Digital Signal Processing students, faculty, and practitioners with a special emphasis on education. This investigation begins with the software maintenance task of restructuring, debugging, and testing the functional version of ICECAP-PC 9.0. The continuous, traditional portions are then ported to a new object-oriented program structure which is the primary focus of this effort. New interactive graphics capabilities are then added as well as new procedures for the time and frequency response plots. All basic math algorithms are re-written to be more accurate within a contemporary personal computer environment. Finally, using a program extension concept called a toolbox, a Multiple-Input-Single-Output (MISO) Quantitative Feedback Theory (QFT) toolbox is created. This toolbox allows manual, interactive, and automatic QFT design for continuous, linear, time invariant MISO control system problems.... Computer Aided Control System Design (CACSD), Controls, Computer Aided Design (CAD), Quantitative Feedback Theory (QFT).
GRA

**N93-19852#** Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.
**SOFTWARE USERS MANUAL FOR THE GENERIC AVIONICS DATA BUS TOOL KIT OF THE Ada TECHNOLOGY INSERTION PROGRAM**
17 Jul. 1992 10 p
(AD-A259364) Avail: CASI HC A02/MF A01

This Software Users Manual (SUM) is written for the Generic Avionics Data Bus Tool Kit (GADBTK) version 1.1. The GADBTK is an Ada Technology Insertion Program (ATIP) sponsored effort to produce an Ada binding with the MIL-STD-1553B time multiplex serial data bus. GRA

**N93-19855#** Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.
**SOFTWARE PROGRAMMERS MANUAL FOR THE GENERIC AVIONICS DATA BUS TOOL KIT TO THE Ada TECHNOLOGY INSERTION PROGRAM**
17 Jul. 1992 8 p
(AD-A259379) Avail: CASI HC A02/MF A01

This Software Programmers Manual (SPM) is written for the Generic Avionics Data Bus Tool Kit (GADBTK) Version 1.1. The GADBTK is an Ada Technology Insertion Program (ATIP) sponsored effort to produce an Ada binding with the MIL-STD-1553B time multiplex serial data bus. GRA

**N93-19948#** Army Topographic Engineering Center, Fort Belvoir, VA.
**THE IMAGE DIGITIZING SYSTEM**
Maurits Roos 23 Nov. 1992 10 p
(AD-A258665; TEC-R-193) Avail: CASI HC A02/MF A01

The conversion of mapping technology in the DoD community from analog- to digital-based technology, which started in the 1980's, required precise equipment to convert aerial photographs to digital data (pixels). These are referred to as image scanners or digitizers. This paper describes the recent development of a precise image scanner by the Topographic Engineering Center (TEC) (formerly ETL). The scanner is called the Image Digitizing System (IDS). This paper describes the general design and operation of the system and many of its unique characteristics. The paper also describes several test results that verify the high-geometric and high-photometric characteristics of the IDS. GRA

**N93-19958#** Carnegie-Mellon Univ., Pittsburgh, PA. School of Computer Science.
**ANALYTICA: AN EXPERIMENT IN COMBINING THEOREM PROVING AND SYMBOLIC COMPUTATION**
Edmund Clarke and Xudong Zhao Oct. 1992 21 p
(Contract F33615-90-C-1465; ARPA Order 7597)
(AD-A258656; CMU-CS-92-147) Avail: CASI HC A03/MF A01

Analytica is an automatic theorem prover for theorems in elementary analysis. The prover is written in Mathematica (TM) language and runs in the Mathematica environment. The goal of the project is to use a powerful symbolic computation system to prove theorems that are beyond the scope of previous automatic theorem provers. The theorem prover is also able to guarantee the correctness of certain steps that are made by the symbolic computation system and therefore prevent common errors like division by a symbolic expression that could be zero. In this paper we describe the structure of Analytica and explain the main techniques that it uses to construct proofs. Analytica was able to prove several non-trivial examples including the basic properties of the stereographic projection and a series of three lemmas that lead to a proof of Weierstrass's example of a continuous nowhere differentiable function. Each of the lemmas in the latter example is proved completely automatically. GRA

**N93-18506#** Aerospace Corp., El Segundo, CA. Advanced Orbital Systems Operations.
**WAVELET IMAGE ANALYSIS**
J. R. LaFrieda, L. A. Campbell, and M. Jankins *In its* Aerospace Sponsored Research 1 Dec. 1991 p 156-158 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18716*#** California Univ., Berkeley. Astronomy Dept.
**DAILY QUALITY ASSURANCE SOFTWARE FOR A SATELLITE RADIOMETER SYSTEM Abstract Only**
P. B. Keegstra, G. F. Smoot, C. L. Bennett, J. Aymon, C. Backus, G. DeAmici, G. Hinshaw, P. D. Jackson, A. Kogut, and C. Lineweaver et al *In* NASA. Goddard Space Flight Center, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

**N93-18746#** Finnish Meteorological Inst., Helsinki.
**GUISDAP Status Report**
Asko Huuskonen *In* Oulu Univ., Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 71-78 (For primary document see N93-18736 06-46)
Avail: CASI HC A02/MF A02

**N93-19187*#** Academy of Sciences (USSR), Leningrad. Inst. of Theoretical Astronomy.
**INTEGRATED SOFTWARE PACKAGE STAMP FOR MINOR PLANETS**
O. M. Kochetova and Viktor A. Shor *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 309-311 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19194*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**EVALUATING SOME COMPUTER EXHANCEMENT ALGORITHMS THAT IMPROVE THE VISIBILITY OF COMETARY MORPHOLOGY**
Stephen M. Larson and Charles D. Slaughter (Photometrics, Inc., Tucson, AZ.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 337-343 (For primary document see N93-19113 06-90)
(Grant NAGw-1974)
Avail: CASI HC A02/MF A04

**N93-19404*#** Portland State Univ., OR. Computer Science Dept.
**DEVELOPMENT OF A TASK ANALYSIS TOOL TO FACILITATE USER INTERFACE DESIGN**

Jean C. Scholtz *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 421-450 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

**N93-19425*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.
**LOCALLY ADAPTIVE VECTOR QUANTIZATION: DATA COMPRESSION WITH FEATURE PRESERVATION**
K. M. Cheung and M. Sayano (California Inst. of Tech., Pasadena.) *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 163-178 (For primary document see N93-19413 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A03/MF A03

**N93-19426*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.
**DATA COMPRESSION BY WAVELET TRANSFORMS**
M. Shahshahani *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 179-187 (For primary document see N93-19413 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A02/MF A03

**N93-19427*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.
**MAXIMAL CODEWORD LENGTHS IN HUFFMAN CODES**
Y. S. Abu-Mostafa (California Inst. of Tech., Pasadena.) and R. J. McEliece *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 188-193 (For primary document see N93-19413 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A02/MF A03

**N93-19428*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.
**COMPARISONS OF THEORETICAL LIMITS FOR SOURCE CODING WITH PRACTICAL COMPRESSION ALGORITHMS**
F. Pollara and S. Dolinar *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 194-201 (For primary document see N93-19413 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A02/MF A03

**N93-19430*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Communications Systems Research Section.
**BINARY WEIGHT DISTRIBUTIONS OF SOME REED-SOLOMON CODES**
F. Pollara and S. Arnold *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 208-215 (For primary document see N93-19413 06-32)
(RTOP 310-30-71-83-04)
Avail: CASI HC A02/MF A03

**N93-19461*#** North Carolina Agricultural and Technical State Univ., Greensboro. Controls and Guidance Group.
**FULL DESIGN OF FUZZY CONTROLLERS USING GENETIC ALGORITHMS**
Abdollah Homaifar and Ed McCormick *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 12 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

**N93-19723** Thinkalong Software, Inc., Brownsville, CA.
**GETTING THE MODEL RIGHT: COUPLING A CELLULAR AUTOMATA TO A DISCOVERY SYSTEM**
Jack Park and Dan Wood *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 82-86 (For primary document see N93-19711 06-82)
(Contract F33615-92-C-5802)
Copyright Avail: Issuing Activity

**N93-19724** Aberdeen Univ. (Scotland). Dept. of Computing Science.
**MACHINE DISCOVERY BY MODEL DRIVEN ANALOGY**
Davide Roverso, Peter Edwards, and Derek Sleeman *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 87-97 (For primary document see N93-19711 06-82)
(Grant EEC-SC1-0048-C)
Copyright Avail: Issuing Activity

**N93-19731** Paris XI Univ., Orsay (France). Inference and Learning Group.
**ARC.2: LINEAR REGRESSION IN ABACUS**
Marjorie Moulet *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 137-146 Sponsored in part by PRC-IA (For primary document see N93-19711 06-82)
(Grant EEC-SC1-0048-C)
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**N93-19732** SRI International Corp., Menlo Park, CA.
**GOAL-DIRECTED LEARNING: A DECISION-THEORETIC MODEL FOR DECIDING WHAT TO LEARN NEXT**
Marie desJardins *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 147-151 (For primary document see N93-19711 06-82)
Copyright Avail: Issuing Activity

**N93-19733** Massachusetts Inst. of Tech., Cambridge. Media Lab.
**CYRANO-3: AN EXPERIMENT IN REPRESENTATIONAL INVENTION**
Kenneth B. Haase *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 153-160 (For primary document see N93-19711 06-82)
Copyright Avail: Issuing Activity

**N93-19763#** Telefunken System Technik G.m.b.H., Ulm (Germany).
**TICAMS: TELEFUNKEN INTEGRATED COMPUTER-AIDED MAINTENANCE SYSTEM**
Werner Wurster *In* AGARD, Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface Oct. 1992 18 p (For primary document see N93-19757 06-54)
Copyright Avail: CASI HC A03/MF A03

**N93-19923#** Naval Air Warfare Center, China Lake, CA.
**DEVELOPMENT AND FLIGHT TESTING OF THE MULTI-SOURCE INTEGRATION ALGORITHMS IN THE F/A-18 MISSION COMPUTER SOFTWARE**
J. J. Crutchfield *In* AGARD, Flight Testing Oct. 1992 5 p (For primary document see N93-19901 06-05)
Copyright Avail: CASI HC A01/MF A04

## 62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

**N93-18185#** California Univ., Los Angeles. Dept. of Computer Science.
**HIGH-LEVEL PARALLEL PROGRAMMING Final Report, May 1991 - May 1992**
Rajive L. Bagrodia Aug. 1992 62 p
(Contract F30602-91-C-0061)
(AD-A257977; RL-TR-92-215) Avail: CASI HC A04/MF A01

This final technical report summarizes research accomplished under the Expert Science and Engineering (ES and E) Program by UCLA. This one-year research effort examined issues in designing parallel programming languages. These issues were evaluated via the utilization of a language called UC. UC is a programming language aimed at balancing notational simplicity with execution efficiency and portability. UC accomplishes this by separating the programming task from the efficiency issues. This report gives a description of the language, its current implementation, its verification methodology, and its use in designing various applications. GRA

**N93-18297#** Boston Univ., MA. Center for Adaptive Systems.
**COMPUTER AND MATHEMATICAL MODELLING OF MASSIVELY PARALLEL ARCHITECTURES FOR SELF-ORGANIZING NEURAL PATTERN RECOGNITION MACHINES Final Technical Report, 1 Jan. 1990 - 30 Jun. 1992**
Stephen Grossberg Oct. 1992 11 p
(Grant AF-AFOSR-0128-90)
(AD-A258167; AFOSR-92-0956TR) Avail: CASI HC A03/MF A01

Substantial progress has been made in several research areas. For example, a new class of neural networks has been developed which are defined by high-dimensional nonlinear dynamics systems that operate at multiple time scales. They are designed to carry out fast, stable, autonomous learning of recognition codes and multidimensional maps in response to arbitrary sequences of input patterns. The new neural network architecture, called ARTMAP, autonomously learns to classify many, arbitrarily ordered vectors into recognition categories based on predictive success. In other research, these investigators developed a new model of temporal prediction that is based upon analysis of how animals and humans learn to time their actions to achieve desired goals. Research was also conducted on the neural dynamics of speech filtering and segmentations, measurement theory, temporal predictions reinforcement learning, and autonomous credit assignment. GRA

**N93-18434#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 1: Architectures Paralleles, Bases de Donnees, Reseaux et Systemes Distribues.
**EFFECTIVENESS OF HEURISTICS AND SIMULATED ANNEALING FOR THE SCHEDULING OF CONCURRENT TASKS: AN EMPIRICAL COMPARISON [EFFICACITE DES HEURISTIQUES ET DU RECUIT SIMULE POUR L'ORDONNANCEMENT DE TACHES CONCURRENTES: UNE COMPARAISON EMPIRIQUE]**
Christophe Coroyer (Centre National de la Recherche Scientifique, Valbonne, France ) and Zhen Liu Jan. 1991 30 p
(INRIA-RR-1379; ETN-93-92629) Avail: CASI HC A03/MF A01

The scheduling of concurrent tasks with precedence constraints in parallel systems in order to minimize the makespan is known to be NP complete. The average effectiveness and the average efficiency of 27 heuristic and 7 simulated annealing algorithms used for the minimization of makespan are studied. A computational experiment showed that the simulated annealing algorithms are very effective compared with the heuristics, provided these algorithms converge. It turns out that some heuristics are quite effective on average, and that the heuristics, provided they are used together, have qualitative behavior not much worse than that of the simulated annealing and are much more efficient. ESA

**N93-18443#** Leiden Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**ON THE OPTIMALITY OF LEPT AND MICRON RULES FOR PARALLEL PROCESSORS AND DEPENDENT ARRIVAL PROCESSES**
Arie Hordijk and Ger Koole 1992 22 p
(TW-92-01; ETN-92-92800) Avail: CASI HC A03/MF A01

Stochastic scheduling problems of multiclass customers in identical parallel processors is discussed. A new type of arrival process, called a Markov decision arrival process, is introduced. Thus, the arrival process can be controlled and can depend on the numbers of customers in the queues. The optimality of LPT (the policy that processes customers in the system in decreasing order of expected processing time) and the mu(C) rule are shown in the last node of a tandem network for various cost structures. A unifying proof using dynamic programming is given. The main lemma which gives two sufficient conditions guaranteeing that LEPT and the mu(C) rule are optimal is presented. The proof of the lemma and cost functions which satisfy the sufficient conditions are given. The optimality of the mu(C) rule without the agreeability condition is studied. It is shown that the mu(C) rule is not optimal in the last center of the tandem network, when the agreeability condition is not satisfied. Further work could be the study of the possible dependence of the arrival process on the queue sizes. ESA

**N93-18890#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**GENERALIZATION AND PARALLELIZATION OF MESSY GENETIC ALGORITHMS AND COMMUNICATION IN PARALLEL GENETIC ALGORITHMS M.S. Thesis**
Laurence D. Merkle Dec. 1992 187 p
(AD-A258994; AFIT/GCE/ENG/92D-08) Avail: CASI HC A09/MF A02

Genetic algorithms (GA) are highly parallelizable, robust semi-optimization algorithms of polynomial complexity. The most commonly implemented GA's are simple GA's (SGA's). Reproduction, crossover, and mutation operate on solution populations. Deceptive and GA-hard problems are probably difficult for simple GA's. Messy GA's (MGA) are designed to overcome these limitations. The MGA is generalized to solve permutation type optimization problems. Its performance is compared to another MGA's, an SGA's, and a permutation SGA's. Against a fully deceptive problem the generalized MGA (GMGA) consistently performs better than the simple GA. Against an NP-complete permutation problem, the GMGA performs better than the other GA's. Against DeJong function f2, the GMGA performs better than the other MGA, but not as well as the SGA. Four parallel MGA data distribution strategies are compared and not found to significantly affect solution quality. The interleaved strategy obtains near linear speedup. The indexed, modified indexed, and block strategies obtain 'super-linear speedup', indicating that the sequential algorithm can be improved. Population partitioning impacts implementation of selection and crossover. Experiments which compare the solution quality, execution time, and convergence characteristics of three selection algorithms and three solution sharing strategies are performed. GRA

**N93-19070#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DEVELOPMENT OF A PROTOCOL USAGE GUIDELINE FOR CONSERVATIVE PARALLEL SIMULATIONS M.S. Thesis**
Prescott J. VanHorn Dec. 1992 118 p
(AD-A258851; AFIT/GCS/ENG/92D-19) Avail: CASI HC A06/MF A02

The objective of distributed simulation is to speedup simulation execution by partitioning the simulation processing load over multiple processors. Current synchronization protocol methods for distributed simulations are reviewed, and guidelines for obtaining optimal conservative simulation partitionings using empirical evidence are proposed. An analysis is performed using three protocol variations of the Chandy-Misra HULL message algorithm, two using a pending message blocking strategy, and the other using a safetime blocking strategy. A fourth protocol evaluated is based on the SRADS algorithm proposed by Reynolds. The analysis involves a study of all possible 2 and 4 node configurations, for three queuing simulations, using all possible protocol and model pairings. A fourth queuing model is then used to independently validate results. In the end, the safetime version of the Chandy-Misra protocol is demonstrated to provide better overall performance than the other protocols evaluated. Partitioning guidelines developed established a relationship between process configurations and load balancing. It is seen that separating highly communicative processes onto different nodes, or locating highly communicative processes on the same node with fewer processes, provided the optimal 4 node configurations, while reducing the number of intra-node process connections provided for the optimal 2 node configurations. GRA

**N93-19510#** Stanford Linear Accelerator Center, CA.
**NETWORK MANAGEMENT, STATUS, AND DIRECTIONS**
R. L. A. Cottrell and T. C. Streater Sep. 1992 4 p Presented at the 10th Conference on Computing in High Energy Physics, Annecy, France, 21-25 Sep. 1992
(Contract DE-AC03-76SF-00515)
(DE93-004003; SU-SLAC-PUB-5913; CONF-920966-7) Avail: CASI HC A01/MF A01

It has been said that the 'network is the system'. This implies providing levels of service, reliability, predictability, and availability that are commensurate with or better than those that individual computers provide today. To provide this service requires integrated network management for interconnected networks of heterogeneous devices covering both the local campus and across the world and spanning many administrative domains. The status of existing tools to address management for networks is reviewed. It draws on experience from both within and outside the High Energy Physics (HEP) community. DOE

**N93-19621#** Northwestern Univ., Evanston, IL. Dept. of Mechanical Engineering.
**A DISCRETE ORDINATE RESPONSE MATRIX METHOD FOR MASSIVELY PARALLEL COMPUTERS**
U. R. Hanebutte and E. E. Lewis 1991 6 p Presented at the International Topical Meeting on Advances in Mathematics, Computation and Reactor Physics, Pittsburgh, PA, 28 Apr. - 2 May 1991
(Contract DE-FG02-88ER-12810)
(DE93-003463; CONF-910414-39) Avail: CASI HC A02/MF A01

A discrete ordinate response matrix method is formulated for the solution of neutron transport problems on massively parallel computers. The response matrix formulation eliminates iteration on the scattering source. The nodal matrices which result from the diamond-differenced equations are utilized in a factored form which minimizes memory requirements and significantly reduces the required number of arithmetic operations per node. The red/black solution algorithm utilizes massive parallelism by assigning each spatial node to a processor. The algorithm is accelerated effectively by a synthetic method in which the low-order diffusion equations are also solved by massively parallel red/black iterations. The method was implemented on a 16k Connection Machine-2, and S(sub 8) and S(sub 16) solutions were obtained for fixed-source benchmark problems in X-Y geometry. DOE

**N93-18503#** Aerospace Corp., El Segundo, CA. Computer Systems Div.
**BARRIER SYNCHRONIZATION OF DISTRIBUTED-MEMORY ARCHITECTURES**
C. A. Lee *In its* Aerospace Sponsored Research 1 Dec. 1991 p 147-149 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

## 63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

**N93-17814#** Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France). Groupe Decentralisation, Hierarchisation, Parallelisme.
**METHODOLOGIES OF AUTOMATIC CONTROL INCLUDING FUZZY LOGIC Ph.D. Thesis - Inst. National des Sciences Appliquees de Toulouse**
Raouf Ketata 1992 211 p In FRENCH
(LAAS-92257; ETN-93-93365) Avail: CASI HC A10/MF A03

Some methodologies concerning conventional automatic control and non-conventional automatic control are presented. The rotor-alternator group (experiment plant) is modeled and conventional techniques like proportional integral derivative (PID) and Self Tuning Controllers (STC) (a case of adaptive control) are addressed. Some methods of tuning the PID parameters are explained. The results on the speed control of the group are compared in both simulation and real time situations. Two STC algorithms, (optimal control and PID) were applied to the process. The fuzzy control, a particular case of non-conventional techniques, was introduced by a detailed description of its different parts (fuzzyfication, control rules, inference, defuzzyfication) and their properties. For this kind of automtic control, a practical method to develop the control agorithm is proposed. This algorithm was applied to three different processes. The first one concerns the speech control of the group. The second is dedicated to the control of the temperature of an industrial furnace; the results obtained are compared with those of a special PID controller. The last represents a comparative study with a supervised adaptive control. Another alternative, which consists of combining conventional and non-conventional techniques in two control schemas is considered. The fuzzy controller and the PID controller are combined in parallel structure and fuzzy logic is used to supervise the PID controller and to tune its parameters. ESA

**N93-17821#** Technische Univ., Munich (Germany). Inst. of Elements.
**PROCEEDINGS OF THE 2ND INTERNATIONAL WORKSHOP ON CELLULAR NEURAL NETWORKS AND THEIR APPLICATIONS**
16 Oct. 1992 293 p Workshop held in Munich, Germany, 14-16 Oct. 1992
(Contract DAJA45-92-M-0405)
(AD-A258245; R/D-6997-EE-03) Avail: CASI HC A13/MF A03

Various types of CNN's are summarized and the taxonomy of CNN is given according to the different types of grids, processors, interactions, and modes of operation. Next, the CNN Universal Machine is introduced. The architecture and the key features are outlined. A quite exhaustive list of references completes the paper. GRA

**N93-17837#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.
**TIME-VARYING FEEDBACK STABILIZATION OF NONHOLONOMIC CAR-LIKE MOBILE ROBOTS**
Claude Samson Sep. 1991 25 p
(INRIA-RR-1515; ETN-93-93369) Avail: CASI HC A03/MF A01

The derivation of a set of smoothing time varying feedbacks for a class of nonlinear systems encompassing simple car models, and sufficient conditions for asymptotic convergence of the state vector to zero is given. Many nonholonomic mechanical systems, such as car like mobile robots, are controllable but cannot be stabilized to given positions and orientations by using smooth pure state feedback control. However, such systems may still be stabilized by using smoothing 'time varying' feedbacks: feedbacks which explicitly depend on the time variable. This possibility is applied to the stabilization of a class of nonlinear systems whose equations encompass simple car models. A set of stabilizing smooth time varying feedbacks is derived and simulation results are given. ESA

**N93-17860#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**NEIGHBORING EXTREMAL GUIDANCE FOR SYSTEMS WITH PIECEWISE LINEAR CONTROL USING MULTIPLE OPTIMIZATION M.S. Thesis**
Michael J. Nowak Aug. 1992 44 p
(AD-A258191; AFIT/CI/CIA-92-102) Avail: CASI HC A03/MF A01

A neighboring extremal guidance law for systems with piecewise linear control using multiple optimization along the suboptimal trajectory is developed. The guidance law computes control gains that relate the difference in the perturbed and nominal trajectory with a control update. Previous research in neighboring extremal control has concentrated on calculating the control gains using a single optimization from the initial conditions to the final constraint manifold. The purpose of this study is to develop a more optimal method of computing the control gains at each node through multiple optimization. Multiple optimization reoptimizes the trajectory from each control node on the suboptimal trajectory. The suboptimal control vectors for each subtrajectory are used to compute a more optimal set of control gains. An example optimization problem, the lunar launch problem, is used to compare the performance of both the single optimization and multiple optimization control laws. Overall, the multiple optimization gains returned results comparable to those achieved with single optimization. For perturbations of + or - 5 percent in either gravity or thrust acceleration, endpoint conditions for multiple optimization gains never exceeded more than 50 feet in position or 4.3 ft/sec in vertical velocity from the desired boundary conditions. Direct comparisons of performance for specific model perturbations result in mixed conclusions. For thrust perturbations, single optimization gains deliver smaller errors in meeting end point conditions, while for gravity perturbations, multiple gains give better results. GRA

**N93-17870#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**DISCRETE-TIME MARKOVIAN JUMP LINEAR SYSTEMS**
K. Szajowski (Wroclaw Univ., Poland ) and W. L. deKoning 1992 22 p
(Rept-92-37; ETN-93-93129) Copyright Avail: CASI HC A03/MF A01

A problem of the optimal control of a linear system with the parameters dependent on the states of a Markov chain is considered. The cost criterion is quadratic of the controls and states of the system. The criterion parameters also depend on the states of the Markov chain. Two models of observation of the Markov chain are adopted: delay for one step and underlay. Under appropriate mean square detectability and stability conditions, the infinite horizon optimal control problem for the general case of Markovian jump linear quadratic systems is shown to have a unique solution when the

control system is mean square stable. Necessary and sufficient conditions are given to determine if a system is mean square stable. ESA

**N93-18296#** Pennsylvania Univ., Philadelphia. School of Engineering and Applied Science.

**COMPUTATIONAL AND NEURAL NETWORK MODELS FOR THE ANALYSIS OF VISUAL TEXTURE Final Report, 1 Sep. 1988 - 31 Jul. 1992**

R. Bajcsy and G. Gerstein 13 Oct. 1992 16 p

(Grant AF-AFOSR-0296-88)

(AD-A258166; AFOSR-92-0951TR) Avail: CASI HC A03/MF A01

The grant supported research efforts in two main research questions: (1) how do we segment and estimate the slant/tilt of natural scenes with highly irregular textures, using both biological and non-biological computing architectures?; and (2) how do we design machine perception and action systems and learning mechanisms that can improve their performance through repeated feedback and interaction with their environment? Section 2 describes the research and publications relating to the slant/tilt and segmentation problem. Section 3 describes research and publications using developmental psychological and machine learning frameworks for learning visuomotor tasks. Finally, Section 4 summarizes the two Ph.D dissertations in the Department of Computer and Information Science made possible with AFOSR support. GRA

**N93-18331** Politecnico di Milano (Italy). Dipt. di Elettronica e Informazione.

**GRAMMATICA: AN OPEN SOFTWARE LABORATORY FOR ARTIFICIAL INTELLIGENCE**

S. Crespi-Reghizzi, L. Breveglieri, F. Cacace, A. Cherubini, G. Lamperti (TXT Ingegneria Informatica S.p.A., Milan, Italy ), D. Fava, M. Lometti, M. Montagnini, G. Psaila, and R. Sartori et al May 1992 18 p Sponsored in part by Italian Ministry of Public Education

(Rept-92-031; ETN-93-93034) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

Grammatica is an open collection of software tools for treating artificial languages. The project is based on rapid prototyping of algorithms using the relational language ALGRES, followed by revision and conversion to more efficient C versions. Development of tools is supported by an evironment, called ATELIER (Autonomous Tool Evolution Laboratory Implemented by Extended Relations), itself evolutionary. The collection is subdivided into three areas, Syntactica, Semantica and Lexica. The current set of tools addresses context free syntax processing, using the topdown deterministic LL(k) approach, and attribute grammars analysis. Work is in progress on scanning and bottom-up syntax analysis. ESA

**N93-18372*#** Calspan-State Univ. of New York Joint Venture, Buffalo, NY.

**THEORETICAL CONSTRAINTS IN THE DESIGN OF MULTIVARIABLE CONTROL SYSTEMS Final Report, Jan. 1993**

E. G. Rynaski and D. J. Mook Jan. 1993 46 p

(Grant NAG1-1361)

(NASA-CR-191900; NAS 1.26:191900) Avail: CASI HC A03/MF A01

The theoretical constraints inherent in the design of multivariable control systems were defined and investigated. These constraints are manifested by the system transmission zeros that limit or bound the areas in which closed loop poles and individual transfer function zeros may be placed. These constraints were investigated primarily in the context of system decoupling or non-interaction. It was proven that decoupling requires the placement of closed loop poles at the system transmission zeros. Therefore, the system transmission zeros must be minimum phase to guarantee a stable decoupled system. Once decoupling has been accomplished, the remaining part of the system exhibits transmission zeros at infinity, so nearly complete design freedom is possible in terms of placing both poles and zeros of individual closed loop transfer functions. A general, dynamic inversion model following system architecture was developed that encompasses both the implicit and explicit configuration. Robustness properties are developed along with other attributes of this type of system. Finally, a direct design is developed for the longitudinal-vertical degrees of freedom of aircraft motion to show how a direct lift flap can be used to improve the pitch-heave maneuvering coordination for enhanced flying qualities. Author

**N93-18377*#** Rensselaer Polytechnic Inst., Troy, NY. Center for Intelligent Robotic Systems for Space Exploration.

**MODEL REFERENCE ADAPTIVE CONTROL OF ROBOTS**

Rodrigo Steinvorth Mar. 1991 107 p

(Grant NAGw-1333)

(NASA-CR-191871; NAS 1.26:191871; RPI-CIRSSE-87) Avail: CASI HC A06/MF A02

This project presents the results of controlling two types of robots using new Command Generator Tracker (CGT) based Direct Model Reference Adaptive Control (MRAC) algorithms. Two mathematical models were used to represent a single-link, flexible joint arm and a Unimation PUMA 560 arm; and these were then controlled in simulation using different MRAC algorithms. Special attention was given to the performance of the algorithms in the presence of sudden changes in the robot load. Previously used CGT based MRAC algorithms had several problems. The original algorithm that was developed guaranteed asymptotic stability only for almost strictly positive real (ASPR) plants. This condition is very restrictive, since most systems do not satisfy this assumption. Further developments to the algorithm led to an expansion of the number of plants that could be controlled, however, a steady state error was introduced in the response. These problems led to the introduction of some modifications to the algorithms so that they would be able to control a wider class of plants and at the same time would asymptotically track the reference model. This project presents the development of two algorithms that achieve the desired results and simulates the control of the two robots mentioned before. The results of the simulations are satisfactory and show that the problems stated above have been corrected in the new algorithms. In addition, the responses obtained show that the adaptively controlled processes are resistant to sudden changes in the load. Author

**N93-18389#** Tennessee Univ., Knoxville. Dept. of Nuclear Engineering.

**FUZZY LOGIC: ARTIFICIAL NEURAL NETWORKS INTEGRATION FOR TRANSIENT IDENTIFICATION**

A. Ikonomopoulos, L. H. Tsoukalas, and R. E. Uhrig 1991 7 p Presented at the ANNIE 1991 Artificial Neural Networks in Engineering Conference, St. Louis, MO, 10-13 Nov. 1991

(Contract DE-FG07-88ER-12824)

(DE93-002232; CONF-9111215-1) Avail: CASI HC A02/MF A01

A methodology is presented that integrates pretrained artificial neural networks (ANN's) with rule-based fuzzy logic systems, for the purpose of distinguishing different transients in a Nuclear Power Plant (NPP). In general this approach appears to provide timely, concise and task specific information about the status of a system under consideration. The pretrained neural network typifies different transient scenarios and derives membership functions which independently represent individual transients. The overall system successfully performs transient identification, in a time span faster or at least comparable to that of transient development. In order to examine the proposed methodology, simulated accidents are used. The results obtained demonstrate the excellent noise tolerance of ANN's and suggest a new approach for transient identification. DOE

**N93-18515#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 1: Architectures Paralleles, Bases de Donnees, Reseaux et Systemes Distribues.

**OPTIMALITY OF A THRESHOLD POLICY ON THE M/M/1 QUEUE WITH REPEATED VACATIONS [OPTIMALITE D'UNE POLITIQUE A SEUIL DANS UNE FILE D'ATTENTE M/M/1 AVEC VACANCES DU SERVEUR]**

Eitan Altman and Philippe Nain Apr. 1991 22 p

(Grant F-ISCCSE-3321190)

(INRIA-RR-1419; ETN-93-92640) Avail: CASI HC A03/MF A01

A study which considers an M/M/1 queueing system with server vacations where the server is turned off as soon as the queue gets empty is presented. It is assumed that the vacation durations form a sequence of independent and identically distributed random variables with exponential distribution. At the end of a vacation period, the server may either be turned on if the queue is non empty or take another vacation. The following costs are incurred: a holding cost of h per unit of time and per customer on the system and a fixed cost of gamma each time the server is turned on. A threshold policy that minimizes the long run average criterion is shown to exist. The optimal threshold and the optimal long run average cost can be determined explicitly in terms of the model parameters. ESA

**N93-18573#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 5: Traitement du Signal, Automatique et Productique.

**USING CONCEPTUAL CLUSTERING TO LEARN ABOUT FUNCTION, STRUCTURE, AND BEHAVIOR IN DESIGN [UTILISATION DU CLUSTERING CONCEPTUEL POUR L'APPRENTISSAGE AUTOMATIQUE DES NOTIONS DE FONCTION, STRUCTURE ET COMPORTEMENT EN CONCEPTION]**

Leiela Alem (Sydney Univ., Australia ) and Mary Lou Maher (Sydney Univ., Australia ) Mar. 1991 20 p

(INRIA-RR-1401; ETN-93-92633) Avail: CASI HC A03/MF A01

Modeling design knowledge is an active research topic among engineers, architects, and artificial intelligence researchers interested in knowledge based design. The primary concerns are knowledge representation and knowledge acquisition. Knowledge acquisition for knowledge based design is difficult because humans acquire design knowledge primarily through experience resulting in a diverse and unstructured body of knowledge. Conceptual clustering, an area of the broad field of machine learning, provides techniques for structuring observations into generalized concepts. Specifically, concept formation shows promise for learning design concepts. A conceptual clustering program is used to learn about design by clustering function, structure, and behavior. These clusters are then used as the basis for learning associations between function, structure and behavior. The resulting representation of design knowledge can be used to provide assistance during the synthesis stage of the design process. ESA

**N93-18579*#** Tennessee State Univ., Nashville. Center of Excellence in Information Systems.

**ROBUST CONTROL WITH STRUCTURED PERTURBATIONS Semiannual Report, 1990 - 1991**

Leehyun Keel Mar. 1991 25 p

(Grant NAG1-863)

(NASA-CR-192195; NAS 1.26:192195) Avail: CASI HC A03/MF A01

This semi-annual report describes continued progress on the research. Among several approaches in this area of research, our approach to the parametric uncertainties are being matured everyday. This approach deals with real parameter uncertainties which other techniques such as H (sup infinity) optimal control, micron analysis and synthesis, and l(sub 1) optimal control cannot deal. The primary assumption of this approach is that the mathematical models are well obtained so that the most of system uncertainties can be translated into parameter uncertainties of their linear system representations. These uncertainties may be due to modeling, nonlinearity of the physical system, some time-varying parameters, etc. In this report period of research, we are concentrating on implementing a computer aided analysis and design tool based on new results on parametric robust stability. This implementation will help us to reveal further details in this approach. Author

**N93-18582*#** Drexel Univ., Philadelphia, PA. Dept. of Electrical and Computer Engineering.

**ROBUST CONTROL OF SYSTEMS WITH REAL PARAMETER UNCERTAINTY AND UNMODELLED DYNAMICS Semiannual Progress Report**

Bor-Chin Chang and Robert Fischl Oct. 1990 35 p

(Grant NAG1-1102)

(NASA-CR-192008; NAS 1.26:192008) Avail: CASI HC A03/MF A01

Two significant contributions have been made during this research period in the research 'Robust Control of Systems with Real Parameter Uncertainty and Unmodelled Dynamics' under NASA Research Grant NAG-1-1102. They are: (1) a fast algorithm for computing the optimal H(sub infinity) norm for the four-block, the two block, or the one-block optimal H(sub infinity) optimization problem; and (2) a construction of an optimal H infinity controller without numerical difficulty. In using GD (Glover and Doyle) or DGKF (Doyle, Glover, Khargonekar, and Francis) approach to solve the standard H infinity norm which required bisection search. In this research period, we developed a very fast iterative algorithm for this computation. Our algorithm was developed based on hyperbolic interpolations which is much faster than any existing algorithm. The lower bound of the parameter, gamma, in the H infinity Riccati equation for solution existence is shown to be the square root of the supremum over all frequencies of the maximum eigenvalue of a given transfer matrix which can be computed easily. The lower band of gamma such that the H infinity Riccati equation has positive semidefinite solution can be also obtained by hyperbolic interpolation search. Another significant result in this research period is the elimination of the numerical difficulties arising in the construction of an optimal H infinity controller by directly applying the Glover and Doyle's state-space formulas. With the fast iterative algorithm for the computation of the optimal H infinity norm and the reliable construction of an optimal H infinity controller, we are ready to apply these tools in the design of robust controllers for the systems with unmodelled uncertainties. These tools will be also very useful when we consider systems with structured uncertainties. Author

**N93-18611#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 5: Traitement du Signal, Automatique et Productique.

**DISCRETE TIME SYSTEM PIECEWISE LINEAR FILTERING WITH SMALL OBSERVATION NOISE [FILTRAGE LINEAIRE PAR MORCEAUX D'UN SYSTEME EN TEMPS DISCRET AVEC PETIT BRUIT D'OBSERVATION]**

Paula MilheirodeOliveira (Porto Univ., Portugal ) and Marie-Christine Roubaud Jun. 1991 66 p In FRENCH

(Contract DAJA45-90-C-0008)

(INRIA-RR-1451; ETN-93-92649) Avail: CASI HC A04/MF A01

A piecewise linear discrete time filtering problem with small observation noise is addressed. Different tests which enable the intervals of linearity of the observation function, especially when it is symmetric, are presented and compared. Over such an interval, an approximation can then be made of the optimal filter by the corresponding Kalman-Bucy filter. Discrete time processes are approximated by diffusions, in order to estimate the probabilities of error and the expected times for taking a decision. ESA

**N93-18624#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 1: Architectures Paralleles, Bases de Donnees, Reseaux et Systemes Distribues.

**ON OPTIMAL POLLING POLICIES [POLITIQUES DE POLLING OPTIMALES]**

Zhen Liu, Philippe Nain, and Don Towsley (Massachusetts Univ., Amherst.) Oct. 1991 26 p

(Grant NSF ASC-88-02764)

(INRIA-RR-1541; ETN-93-92663) Avail: CASI HC A03/MF A01

A study to find polling policies that stochastically minimize the unfinished work and the number of customers in the system at all times is presented. This optimization problem is decomposed into three subproblems: determine the optimal action (serve, switch, idle) when the server is at nonempty queue; determine the optimal action (switch, idle) when the server empties a queue; determine the optimal routing (choice of the queue) when the server empties a queue and decides to switch. Under fairly general assumptions, for the first subproblem, optimal policies are shown to be greedy and exhaustive: the server should neither idle nor switch when it is at a nonempty queue. For the second subproblem, in symmetric polling systems, patient policies are shown to be optimal: the server should stay idling at the last visited queue whenever the system is empty. When the system is slotted, it is further proved that non idling and impatient policies are optimal. For the third subproblem, it is established that in symmetric polling systems optimal policies belong to the class of Stochastically Largest Queue (SLQ) policies. An SLQ policy is one that never routes the server to a queue known to have a queue length that is stochastically smaller than that of another queue. This result implies, in particular, that the policy that routes the server to the queue with the largest queue length is optimal when all queue lengths are known and that the cyclic routing policy is optimal in the case that the only information available is the previous decisions. ESA

**N93-18633#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.

**ESTIMATION OF ANGULAR VELOCITY AND ACCELERATION FROM SHAFT ENCODER MEASUREMENTS**

Pierre R. Belanger (McGill Univ., Montreal, Quebec ) May 1991 103 p

(INRIA-RR-1436; TR-CIM-91-1; ETN-93-92644) Avail: CASI HC A06/MF A02

A method of angular velocity and acceleration measurement by finite difference of angle measurement (net pulse counts) at regular time samples

is given which shows that these estimates become significantly degraded as sampling rates increase. Kalman filtering of the angle measurements, based on some model of signal generation, is proposed. An asymptotic analysis at a constant sampling rate as the intersample time tends to zero shows that the error variances tend to zero, but at decreasing rates for the angle, velocity, and acceleration errors. The analysis also suggests the use of multiple integrator systems to model the angle signal. A triple integrator model is used if the acceleration is to be estimated, or a double-integrator model if it is not. ESA

**N93-18659*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA. Artificial Intelligence Research Branch.

**WORKING NOTES FROM THE 1992 AAAI SPRING SYMPOSIUM ON PRACTICAL APPROACHES TO SCHEDULING AND PLANNING**

Mark Drummond (Sterling Software, Pasadena, CA.), Mark Fox (Toronto Univ., Downsview, Ontario ), Austin Tate (Edinburgh Univ., Scotland ), and Monte Zweben May 1992 186 p Symposium held at Stanford Univ., 25-27 Mar. 1992; sponsored by the American Association for Artificial Intelligence

(NASA-TM-108124; FIA-92-17; NAS 1.15:108124) Avail: CASI HC A09/MF A02

The symposium presented issues involved in the development of scheduling systems that can deal with resource and time limitations. To qualify, a system must be implemented and tested to some degree on non-trivial problems (ideally, on real-world problems). However, a system need not be fully deployed to qualify. Systems that schedule actions in terms of metric time constraints typically represent and reason about an external numeric clock or calendar and can be contrasted with those systems that represent time purely symbolically. The following topics are discussed: integrating planning and scheduling; integrating symbolic goals and numerical utilities; managing uncertainty; incremental rescheduling; managing limited computation time; anytime scheduling and planning algorithms, systems; dependency analysis and schedule reuse; management of schedule and plan execution; and incorporation of discrete event techniques. For individual titles, see N93-18660 through N93-18694.

**N93-18660*#** Space Telescope Science Inst., Baltimore, MD.

**SPIKE: AI SCHEDULING FOR HUBBLE SPACE TELESCOPE AFTER 18 MONTHS OF ORBITAL OPERATIONS**

Mark D. Johnston *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Pratical Approaches to Scheduling and Planning May 1992 p 1-5 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

This paper is a progress report on the Spike scheduling system, developed by the Space Telescope Science Institute for long-term scheduling of Hubble Space Telescope (HST) observations. Spike is an activity-based scheduler which exploits artificial intelligence (AI) techniques for constraint representation and for scheduling search. The system has been in operational use since shortly after HST launch in April 1990. Spike was adopted for several other satellite scheduling problems; of particular interest was the demonstration that the Spike framework is sufficiently flexible to handle both long-term and short-term scheduling, on timescales of years down to minutes or less. We describe the recent progress made in scheduling search techniques, the lessons learned from early HST operations, and the application of Spike to other problem domains. We also describe plans for the future evolution of the system. Author

**N93-18661*#** Carnegie-Mellon Univ., Pittsburgh, PA. The Robotics Inst.

**TEMPORAL PLANNING FOR TRANSPORTATION PLANNING AND SCHEDULING**

Robert E. Frederking and Nicola Muscettola *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 6-10 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

In this paper we describe preliminary work done in the CORTES project, applying the Heuristic Scheduling Testbed System (HSTS) to a transportation planning and scheduling domain. First, we describe in more detail the transportation problems that we are addressing. We then describe the fundamental characteristics of HSTS and we concentrate on the representation of multiple capacity resources. We continue with a more detailed description of the transportation planning problem that we have initially addressed in HSTS and of its solution. Finally we describe future directions for our research. Author

**N93-18662*#** McDonnell-Douglas Space Systems Co., Houston, TX. Planning and Scheduling Technology Group.

**A SIMULATED ANNEALING APPROACH TO SCHEDULE OPTIMIZATION FOR THE SES FACILITY**

Mary Beth McMahon and Jack Dean *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 11-14 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

The Shuttle Engineering Simulator (SES) is a facility which houses the software and hardware for a variety of simulation systems. The simulators include the Autonomous Remote Manipulator, the Manned Maneuvering Unit, Orbiter/Space Station docking, and shuttle entry and landing. The SES simulators are used by various groups throughout NASA. For example, astronauts use the SES to practice maneuvers with the shuttle equipment; programmers use the SES to test flight software; and engineers use the SES for design and analysis studies. Due to its high demand, the SES is busy twenty-four hours a day and seven days a week. Scheduling the facility is a problem that is constantly growing and changing with the addition of new equipment. Currently a number of small independent programs have been developed to help solve the problem, but the long-term answer lies in finding a flexible, integrated system that provides the user with the ability to create, optimize, and edit the schedule. COMPASS is an interactive and highly flexible scheduling system. However, until recently COMPASS did not provide any optimization features. This paper describes the simulated annealing extension to COMPASS. It now allows the user to interweave schedule creation, revision, and optimization. This practical approach was necessary in order to satisfy the operational requirements of the SES. Author

**N93-18663*#** Carnegie-Mellon Univ., Pittsburgh, PA. The Robotics Inst.

**DECOMPOSABILITY AND SCALABILITY IN SPACE-BASED OBSERVATORY SCHEDULING**

Nicola Muscettola and Stephen F. Smith *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 15-19 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

In this paper, we discuss issues of problem and model decomposition within the HSTS scheduling framework. HSTS was developed and originally applied in the context of the Hubble Space Telescope (HST) scheduling problem, motivated by the limitations of the current solution and, more generally, the insufficiency of classical planning and scheduling approaches in this problem context. We first summarize the salient architectural characteristics of HSTS and their relationship to previous scheduling and AI planning research. Then, we describe some key problem decomposition techniques supported by HSTS and underlying our integrated planning and scheduling approach, and we discuss the leverage they provide in solving space-based observatory scheduling problems. Author

**N93-18664*#** Honeywell, Inc., Minneapolis, MN. Honeywell Systems and Research Center.

**EXTENDED ABSTRACT: MANAGING DISJUNCTION FOR PRACTICAL TEMPORAL REASONING**

Mark Boddy (Advanced Research Projects Agency, Washington, DC.), Bob Schrag, and Jim Carciofini *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 20-24 (For primary document see N93-18659 06-63)

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Avail: CASI HC A01/MF A02

One of the problems that must be dealt with in either a formal or implemented temporal reasoning system is the ambiguity arising from uncertain information. Lack of precise information about when events happen leads to uncertainty regarding the effects of those events. Incomplete information and nonmonotonic inference lead to situations where there is more than one set of possible inferences, even when there is no temporal

uncertainty at all. In an implemented system, this ambiguity is a computational problem as well as a semantic one. In this paper, we discuss some of the sources of this ambiguity, which we will treat as explicit disjunction, in the sense that ambiguous information can be interpreted as defining a set of possible inferences. We describe the application of three techniques for managing disjunction in an implementation of Dean's Time Map Manager. Briefly, the disjunction is either: removed by limiting the expressive power of the system, or approximated by a weaker form of representation that subsumes the disjunction. We use a combination of these methods to implement an expressive and efficient temporal reasoning engine that performs sound inference in accordance with a well-defined formal semantics. Author

**N93-18665*#** Bull HN Italia, Milan. Direzione Sistemi Esperti.
**SCHEDULING OF AN AIRCRAFT FLEET**
Massimo Paltrinieri, Alberto Momigliano, and Franco Torquati *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 25-29 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

Scheduling is the task of assigning resources to operations. When the resources are mobile vehicles, they describe routes through the served stations. To emphasize such aspect, this problem is usually referred to as the routing problem. In particular, if vehicles are aircraft and stations are airports, the problem is known as aircraft routing. This paper describes the solution to such a problem developed in OMAR (Operative Management of Aircraft Routing), a system implemented by Bull HN for Alitalia. In our approach, aircraft routing is viewed as a Constraint Satisfaction Problem. The solving strategy combines network consistency and tree search techniques. Author

**N93-18666*#** Siemens-Allis, Inc., Cherry Hill, NJ.
**ADAPTIVE PLANNING FOR APPLICATIONS WITH DYNAMIC OBJECTIVES**
Khosrow Hadavi, Wen-Ling Hsu, and Michael Pinedo (Columbia Univ., New York, NY.) *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 30-31 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

We devise a qualitative control layer to be integrated into a real-time multi-agent reactive planner. The reactive planning system consists of distributed planning agents attending to various perspectives of the task environment. Each perspective corresponds to an objective. The set of objectives considered are sometimes in conflict with each other. Each agent receives information about events as they occur, and a set of actions based on heuristics can be taken by the agents. Within the qualitative control scheme, we use a set of qualitative feature vectors to describe the effects of applying actions. A qualitative transition vector is used to denote the qualitative distance between the current state and the target state. We will then apply on-line learning at the qualitative control level to achieve adaptive planning. Our goal is to design a mechanism to refine the heuristics used by the reactive planner every time an action is taken toward achieving the objectives, using feedback from the results of the actions. When the outcome is compared with expectations, our prior objectives may be modified and a new set of objectives (or a new assessment of the relative importance of the different objectives) can be introduced. Because we are able to obtain better estimates of the time-varying objectives, the reactive strategies can be improved and better prediction can be achieved. Author

**N93-18667*#** BIM SA/NV, Everberg (Belgium).
**GLOBAL PLANNING OF SEVERAL PLANTS**
Sylvie Bescos *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 32-36 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

This paper discusses an attempt to solve the problem of planning several pharmaceutical plants at a global level. The interest in planning at this level is to increase the global control over the production process, to improve its overall efficiency, and to reduce the need for interaction between production plants. In order to reduce the complexity of this problem and to make it tractable, some abstractions were made. Based on these abstractions, a prototype is being developed within the framework of the EUREKA project PROTOS, using Constraint Logic Programming techniques. Author

**N93-18668*#** Carnegie-Mellon Univ., Pittsburgh, PA. Center for Integrated Manufacturing Decision Systems.
**THE MICRO-BOSS SCHEDULING SYSTEM: CURRENT STATUS AND FUTURE EFFORTS**
Norman M. Sadeh *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Pratical Approaches to Scheduling and Planning May 1992 p 37-41 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

In this paper, a micro-opportunistic approach to factory scheduling was described that closely monitors the evolution of bottlenecks during the construction of the schedule and continuously redirects search towards the bottleneck that appears to be most critical. This approach differs from earlier opportunistic approaches, as it does not require scheduling large resource subproblems or large job subproblems before revising the current scheduling strategy. This micro-opportunistic approach was implemented in the context of the MICRO-BOSS factory scheduling system. A study comparing MICRO-BOSS against a macro-opportunistic scheduler suggests that the additional flexibility of the micro-opportunistic approach to scheduling generally yields important reductions in both tardiness and inventory. Current research efforts include: adaptation of MICRO-BOSS to deal with sequence-dependent setups and development of micro-opportunistic reactive scheduling techniques that will enable the system to patch the schedule in the presence of contingencies such as machine breakdowns, raw materials arriving late, job cancellations, etc. Author

**N93-18669*#** California Inst. of Tech., Pasadena. Jet Propulsion Lab.
**ITERATIVE REFINEMENT SCHEDULING**
Eric Biefeld *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 42-46 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

We present a heuristics-based approach to deep space mission scheduling which is modeled on the approach used by expert human schedulers in producing schedules for planetary encounters. New chronological evaluation techniques are used to focus the search by using information gained during the scheduling process to locate, classify, and resolve regions of conflict. Our approach is based on the assumption that during the construction of a schedule there exist several disjunct temporal regions where the demand for one resource type or a single temporal constraint dominates (bottleneck regions). If the scheduler can identify these regions and classify them based on their dominant constraint, then the scheduler can select the scheduling heuristic. Author

**N93-18670*#** Carnegie-Mellon Univ., Pittsburgh, PA. The Robotics Inst.
**CABINS: CASE-BASED INTERACTIVE SCHEDULER**
Kazuo Miyashita and Katia Sycara *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 47-51 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

In this paper we discuss the need for interactive factory schedule repair and improvement, and we identify case-based reasoning (CBR) as an appropriate methodology. Case-based reasoning is the problem solving paradigm that relies on a memory for past problem solving experiences (cases) to guide current problem solving. Cases similar to the current case are retrieved from the case memory, and similarities and differences of the current case to past cases are identified. Then a best case is selected, and its repair plan is adapted to fit the current problem description. If a repair solution fails, an explanation for the failure is stored along with the case in memory, so that the user can avoid repeating similar failures in the future. So far we have identified a number of repair strategies and tactics for factory scheduling and have implemented a part of our approach in a prototype system, called CABINS. As a future work, we are going to scale up CABINS to evaluate its usefulness in a real manufacturing environment. Author

**N93-18671*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH. Sverdrup Technology Inc.

**SCHEDULING LESSONS LEARNED FROM THE AUTONOMOUS POWER SYSTEM**

Mark J. Ringer *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 52-56 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

The Autonomous Power System (APS) project at NASA LeRC is designed to demonstrate the applications of integrated intelligent diagnosis, control, and scheduling techniques to space power distribution systems. The project consists of three elements: the Autonomous Power Expert System (APEX) for Fault Diagnosis, Isolation, and Recovery (FDIR); the Autonomous Intelligent Power Scheduler (AIPS) to efficiently assign activities start times and resources; and power hardware (Brassboard) to emulate a space-based power system. The AIPS scheduler was tested within the APS system. This scheduler is able to efficiently assign available power to the requesting activities and share this information with other software agents within the APS system in order to implement the generated schedule. The AIPS scheduler is also able to cooperatively recover from fault situations by rescheduling the affected loads on the Brassboard in conjunction with the APEX FDIR system. AIPS served as a learning tool and an initial scheduling testbed for the integration of FDIR and automated scheduling systems. Many lessons were learned from the AIPS scheduler and are now being integrated into a new scheduler called SCRAP (Scheduler for Continuous Resource Allocation and Planning). This paper will service three purposes: an overview of the AIPS implementation, lessons learned from the AIPS scheduler, and a brief section on how these lessons are being applied to the new SCRAP scheduler. Author

**N93-18672*#** Texas Instruments, Inc., Dallas. Semiconductor Process Development Center.

**PLANNING FOR THE SEMICONDUCTOR MANUFACTURER OF THE FUTURE**

Hugh E. Fargher and Richard A. Smith *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 57-61 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

Texas Instruments (TI) is currently contracted by the Air Force Wright Laboratory and the Defense Advanced Research Projects Agency (DARPA) to develop the next generation flexible semiconductor wafer fabrication system called Microelectronics Manufacturing Science & Technology (MMST). Several revolutionary concepts are being pioneered on MMST, including the following: new single-wafer rapid thermal processes, in-situ sensors, cluster equipment, and advanced Computer Integrated Manufacturing (CIM) software. The objective of the project is to develop a manufacturing system capable of achieving an order of magnitude improvement in almost all aspects of wafer fabrication. TI was awarded the contract in Oct., 1988, and will complete development with a fabrication facility demonstration in April, 1993. An important part of MMST is development of the CIM environment responsible for coordinating all parts of the system. The CIM architecture being developed is based on a distributed object oriented framework made of several cooperating subsystems. The software subsystems include the following: process control for dynamic control of factory processes; modular processing system for controlling the processing equipment; generic equipment model which provides an interface between processing equipment and the rest of the factory; specification system which maintains factory documents and product specifications; simulator for modelling the factory for analysis purposes; scheduler for scheduling work on the factory floor; and the planner for planning and monitoring of orders within the factory. This paper first outlines the division of responsibility between the planner, scheduler, and simulator subsystems. It then describes the approach to incremental planning and the way in which uncertainty is modelled within the plan representation. Finally, current status and initial results are described. Author

**N93-18673*#** Wien Univ. (Austria). Christian Doppler Lab. for Expert Systems.

**UNCERTAINTY MANAGEMENT BY RELAXATION OF CONFLICTING CONSTRAINTS IN PRODUCTION PROCESS SCHEDULING**

Juergen Dorn, Wolfgang Slany, and Christian Stary *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 62-66 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

Mathematical-analytical methods as used in Operations Research approaches are often insufficient for scheduling problems. This is due to three reasons: the combinatorial complexity of the search space, conflicting objectives for production optimization, and the uncertainty in the production process. Knowledge-based techniques, especially approximate reasoning and constraint relaxation, are promising ways to overcome these problems. A case study from an industrial CIM environment, namely high-grade steel production, is presented to demonstrate how knowledge-based scheduling with the desired capabilities could work. By using fuzzy set theory, the applied knowledge representation technique covers the uncertainty inherent in the problem domain. Based on this knowledge representation, a classification of jobs according to their importance is defined which is then used for the straightforward generation of a schedule. A control strategy which comprises organizational, spatial, temporal, and chemical constraints is introduced. The strategy supports the dynamic relaxation of conflicting constraints in order to improve tentative schedules. Author

**N93-18674*#** Heuristicrats, Berkeley, CA. Computer Science Div.

**EXPERIMENTS WITH A DECISION-THEORETIC SCHEDULER**

Othar Hansson, Gerhard Holt, and Andrew Mayer *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 67-71 (For primary document see N93-18659 06-63)

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This paper describes DTS, a decision-theoretic scheduler designed to employ state-of-the-art probabilistic inference technology to speed the search for efficient solutions to constraint-satisfaction problems. Our approach involves assessing the performance of heuristic control strategies that are normally hard-coded into scheduling systems, and using probabilistic inference to aggregate this information in light of features of a given problem. BPS, the Bayesian Problem-Solver, introduced a similar approach to solving single-agent and adversarial graph search problems, yielding orders-of-magnitude improvement over traditional techniques. Initial efforts suggest that similar improvements will be realizable when applied to typical constraint-satisfaction scheduling problems. Author

**N93-18675*#** California Univ., Davis. Dept. of Computer Science.

**GENERATING EFFECTIVE PROJECT SCHEDULING HEURISTICS BY ABSTRACTION AND RECONSTITUTION**

Bhaskar Janakiraman and Armand Prieditis *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 72-76 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

A project scheduling problem consists of a finite set of jobs, each with fixed integer duration, requiring one or more resources such as personnel or equipment, and each subject to a set of precedence relations, which specify allowable job orderings, and a set of mutual exclusion relations, which specify jobs that cannot overlap. No job can be interrupted once started. The objective is to minimize project duration. This objective arises in nearly every large construction project--from software to hardware to buildings. Because such project scheduling problems are NP-hard, they are typically solved by branch-and-bound algorithms. In these algorithms, lower-bound duration estimates (admissible heuristics) are used to improve efficiency. One way to obtain an admissible heuristic is to remove (abstract) all resources and mutual exclusion constraints and then obtain the minimal project duration for the abstracted problem; this minimal duration is the admissible heuristic. Although such abstracted problems can be solved efficiently, they yield inaccurate admissible heuristics precisely because those constraints that are central to solving the original problem are abstracted. This paper describes a method to reconstitute the abstracted constraints back into the solution to the abstracted problem while maintaining efficiency, thereby generating better admissible heuristics. Our results suggest that reconstitution can make good admissible heuristics even better. Author

**N93-18676*#** Oregon State Univ., Corvallis. Dept. of Computer Science.
**REAL-TIME SCHEDULING USING MINIMUM SEARCH**
Prasad Tadepalli and Varad Joshi *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 77-81 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

In this paper we consider a simple model of real-time scheduling. We present a real-time scheduling system called RTS which is based on Korf's Minimin algorithm. Experimental results show that the schedule quality initially improves with the amount of look-ahead search and tapers off quickly. So it sppears that reasonably good schedules can be produced with a relatively shallow search. Author

**N93-18677*#** Sterling Software, Pasadena, CA.
**PLANNING, SCHEDULING, AND CONTROL FOR AUTOMATIC TELESCOPES**
Mark Drummond, Keith Swanson (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.), Andy Philips, Rich Levinson (RECOM Software, Inc., Moffett Field, CA.), and John Bresina *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 82-86 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

This paper presents an argument for the appropriateness of Entropy Reduction Engine (ERE) technology to the planning, scheduling, and control components of Automatic Photoelectric Telescope (APT) management. The paper is organized as follows. In the next section, we give a brief summary of the planning and scheduling requirements for APTs. Following this, in section 3, we give an ERE project precis, couched primarily in terms of project objectives. Section 4 gives a sketch of the match-up between problem and technology, and section 5 outlines where we want to go with this work. Author

**N93-18678*#** Edinburgh Univ. (Scotland). Artificial Intelligence Applications Inst.
**O-Plan2: THE OPEN PLANNING ARCHITECTURE**
Brian Drabble, Richard Kirby, and Austin Tate *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 87-91 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

The O-Plan2 Project at the Artificial Intelligence Applications Institute of the University of Edinburgh is exploring a practical computer based environment to provide for specification, generation, interaction with, and execution of activity plans. O-Plan2 is intended to be a domain-independent general planning and control framework with the ability to embed detailed knowledge of the domain. Various aspects of the project are presented. Author

**N93-18679*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**RESCHEDULING WITH ITERATIVE REPAIR**
Monte Zweben, Eugene Davis (RECOM Software, Inc., Moffett Field, CA.), Brian Daun (Lockheed Space Operations Co., Washington, DC.), and Michael Deale (Lockheed Space Operations Co., Washington, DC.) *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 92-96 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

This paper presents a new approach to rescheduling called constraint-based iterative repair. This approach gives our system the ability to satisfy domain constraints, address optimization concerns, minimize perturbation to the original schedule, and produce modified schedules quickly. The system begins with an initial, flawed schedule and then iteratively repairs constraint violations until a conflict-free schedule is produced. In an empirical demonstration, we vary the importance of minimizing perturbation and report how fast the system is able to resolve conflicts in a given time bound. These experiments were performed within the domain of Space Shuttle ground processing. Author

**N93-18680*#** Edinburgh Univ. (Scotland). Dept. of Artificial Intelligence.
**REALIZATION OF HIGH QUALITY PRODUCTION SCHEDULES: STRUCTURING QUALITY FACTORS VIA ITERATION OF USER SPECIFICATION PROCESSES**
Takashi Hamazaki *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 97-101 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

This paper describes an architecture for realizing high quality production schedules. Although quality is one of the most important aspects of production scheduling, it is difficult, even for a user, to specify precisely. However, it is also true that the decision as to whether a scheduler is good or bad can only be made by the user. This paper proposes the following: (1) the quality of a schedule can be represented in the form of quality factors, i.e. constraints and objectives of the domain, and their structure; (2) quality factors and their structure can be used for decision making at local decision points during the scheduling process; and (3) that they can be defined via iteration of user specification processes. Author

**N93-18681*#** Texas Instruments, Inc., Dallas. Semiconductor Process and Design Center.
**SCHEDULING REVISITED WORKSTATIONS IN INTEGRATED-CIRCUIT FABRICATION**
Paul J. Kline *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 102-106 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

The cost of building new semiconductor wafer fabrication factories has grown rapidly, and a state-of-the-art fab may cost 250 million dollars or more. Obtaining an acceptable return on this investment requires high productivity from the fabrication facilities. This paper describes the Photo Dispatcher system which was developed to make machine-loading recommendations on a set of key fab machines. Dispatching policies that generally perform well in job shops (e.g., Shortest Remaining Processing Time) perform poorly for workstations such as photolithography which are visited several times by the same lot of silicon wafers. The Photo Dispatcher evaluates the history of workloads throughout the fab and identifies bottleneck areas. The scheduler then assigns priorities to lots depending on where they are headed after photolithography. These priorities are designed to avoid starving bottleneck workstations and to give preference to lots that are headed to areas where they can be processed with minimal waiting. Other factors considered by the scheduler to establish priorities are the nearness of a lot to the end of its process flow and the time that the lot has already been waiting in queue. Simulations that model the equipment and products in one of Texas Instrument's wafer fabs show the Photo Dispatcher can produce a 10 percent improvement in the time required to fabricate integrated circuits. Author

**N93-18682*#** Toulouse Univ. (France).
**MULTI-AGENT PLANNING AND SCHEDULING, EXECUTION MONITORING AND INCREMENTAL RESCHEDULING: APPLICATION TO MOTORWAY TRAFFIC**
Pascal Mourou and Bernard Fade *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 107-111 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

This article describes a planning method applicable to agents with great perception and decision-making capabilities and the ability to communicate with other agents. Each agent has a task to fulfill allowing for the actions of other agents in its vicinity. Certain simultaneous actions may cause conflicts because they require the same resource. The agent plans each of its actions and simultaneously transmits these to its neighbors. In a similar way, it receives plans from the other agents and must take account of these plans. The planning method allows us to build a distributed scheduling system. Here, these agents are robot vehicles on a highway communicating by radio. In this environment, conflicts between agents concern the allocation of space in time and are connected with the inertia of the vehicles. Each vehicle made a temporal, spatial, and situated reasoning in order to drive without collision. The flexibility and reactivity of the method

presented here allows the agent to generate its plan based on assumptions concerning the other agents and then check these assumptions progressively as plans are received from the other agents. A multi-agent execution monitoring of these plans can be done, using data generated during planning and the multi-agent decision-making algorithm described here. A selective backtrack allows us to perform incremental rescheduling. Author

**N93-18683*#** Martin Marietta Aerospace, Denver, CO.
**REAL-TIME CONTINGENCY HANDLING IN MAESTRO**
Daniel L. Britt and Amy L. Geoffroy *In* NASA. Ames Research Center, Working notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 112-116 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

A scheduling and resource management system named MAESTRO was interfaced with a Space Station Module Power Management and Distribution (SSM/PMAD) breadboard at MSFC. The combined system serves to illustrate the integration of planning, scheduling, and control in a realistic, complex domain. This paper briefly describes the functional elements of the combined system, including normal and contingency operational scenarios, then focusses on the method used by the scheduler to handle real-time contingencies. Author

**N93-18684*#** California Inst. of Tech., Pasadena.
**LEARNING TO INTEGRATE REACTIVITY AND DELIBERATION IN UNCERTAIN PLANNING AND SCHEDULING PROBLEMS**
Steve A. Chien, Melinda T. Gervasio, and Gerald F. DeJong *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 117-121 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

This paper describes an approach to planning and scheduling in uncertain domains. In this approach, a system divides a task on a goal by goal basis into reactive and deliberative components. Initially, a task is handled entirely reactively. When failures occur, the system changes the reactive/deliverative goal division by moving goals into the deliberative component. Because our approach attempts to minimize the number of deliberative goals, we call our approach Minimal Deliberation (MD). Because MD allows goals to be treated reactively, it gains some of the advantages of reactive systems: computational efficiency, the ability to deal with noise and non-deterministic effects, and the ability to take advantage of unforseen opportunities. However, because MD can fall back upon deliberation, it can also provide some of the guarantees of classical planning, such as the ability to deal with complex goal interactions. This paper describes the Minimal Deliberation approach to integrating reactivity and deliberation and describe an ongoing application of the approach to an uncertain planning and scheduling domain. Author

**N93-18685*#** Illinois Univ., Urbana. Beckman Inst. for Advanced Science and Technology.
**COMPLETABLE SCHEDULING: AN INTEGRATED APPROACH TO PLANNING AND SCHEDULING**
Melinda T. Gervasio and Gerald F. DeJong *In* NASA. Ames Research Center, Working notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 122-126 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

The planning problem has traditionally been treated separately from the scheduling problem. However, as more realistic domains are tackled, it becomes evident that the problem of deciding on an ordered set of tasks to achieve a set of goals cannot be treated independently of the problem of actually allocating resources to the tasks. Doing so would result in losing the robustness and flexibility needed to deal with imperfectly modeled domains. Completable scheduling is an approach which integrates the two problems by allowing an a priori planning module to defer particular planning decisions, and consequently the associated scheduling decisions, until execution time. This allows a completable scheduling system to maximize plan flexibility by allowing runtime information to be taken into consideration when making planning and scheduling decision. Furthermore, through the criteria of achievability placed on deferred decision, a completable scheduling system is able to retain much of the goal-directedness and guarantees of achievement afforded by a priori planning. The completable scheduling approach is further enhanced by the use of contingent explanation-based learning, which enables a completable scheduling system to learn general completable plans from example and improve its performance through experience. Initial experimental results show that completable scheduling outperforms classical scheduling as well as pure reactive scheduling in a simple scheduling domain. Author

**N93-18686*#** Chicago Univ., IL. Artificial Intelligence Lab.
**IOPS ADVISOR: RESEARCH IN PROGRESS ON KNOWLEDGE-INTENSIVE METHODS FOR IRREGULAR OPERATIONS AIRLINE SCHEDULING**
John E. Borse and Christopher C. Owens *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 127-130 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

Our research focuses on the problem of recovering from perturbations in large-scale schedules, specifically on the ability of a human-machine partnership to dynamically modify an airline schedule in response to unanticipated disruptions. This task is characterized by massive interdependencies and a large space of possible actions. Our approach is to apply the following: qualitative, knowledge-intensive techniques relying on a memory of stereotypical failures and appropriate recoveries; and quantitative techniques drawn from the Operations Research community's work on scheduling. Our main scientific challenge is to represent schedules, failures, and repairs so as to make both sets of techniques applicable to the same data. This paper outlines ongoing research in which we are cooperating with United Airlines to develop our understanding of the scientific issues underlying the practicalities of dynamic, real-time schedule repair. Author

**N93-18687*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA. AI Research Branch.
**AN EXTENDED ABSTRACT: A HEURISTIC REPAIR METHOD FOR CONSTRAINT-SATISFACTION AND SCHEDULING PROBLEMS**
Steven Minton, Mark D. Johnston (Space Telescope Science Inst., Baltimore, MD.), Andrew B. Philips, and Philip Laird *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 131-135 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

The work described in this paper was inspired by a surprisingly effective neural network developed for scheduling astronomical observations on the Hubble Space Telescope. Our heuristic constraint satisfaction problem (CSP) method was distilled from an analysis of the network. In the process of carrying out the analysis, we discovered that the effectiveness of the network has little to do with its connectionist implementation. Furthermore, the ideas employed in the network can be implemented very efficiently within a symbolic CSP framework. The symbolic implementation is extremely simple. It also has the advantage that several different search strategies can be employed, although we have found that hill-climbing methods are particularly well-suited for the applications that we have investigated. We begin the paper with a brief review of the neural network. Following this, we describe our symbolic method for heuristic repair. Author

**N93-18688*#** Leeds Univ. (England). Div. of Artificial Intelligence.
**COMBINING CONSTRAINT SATISFACTION AND LOCAL IMPROVEMENT ALGORITHMS TO CONSTRUCT ANAESTHETISTS' ROTAS**
Barbara M. Smith and Sean Bennett *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 136-140 (For primary document see N93-18659 06-63)
Avail: CASI HC A01/MF A02

A system is described which was built to compile weekly rotas for the anaesthetists in a large hospital. The rota compilation problem is an optimization problem (the number of tasks which cannot be assigned to an anaesthetist must be minimized) and was formulated as a constraint satisfaction problem (CSP). The forward checking algorithm is used to find a feasible rota, but because of the size of the problem, it cannot find an optimal (or even a good enough) solution in an acceptable time. Instead, an algorithm was devised which makes local improvements to a feasible

solution. The algorithm makes use of the constraints as expressed in the CSP to ensure that feasibility is maintained, and produces very good rotas which are being used by the hospital involved in the project. It is argued that formulation as a constraint satisfaction problem may be a good approach to solving discrete optimization problems, even if the resulting CSP is too large to be solved exactly in an acceptable time. A CSP algorithm may be able to produce a feasible solution which can then be improved, giving a good, if not provably optimal, solution. Author

**N93-18689*#** Booz-Allen and Hamilton, Inc., Palo Alto, CA. Advanced Decision Systems.

**JIGSAW: PREFERENCE-DIRECTED, CO-OPERATIVE SCHEDULING**

Theodore A. Linden and David Gaw *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 141-144 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

Techniques that enable humans and machines to cooperate in the solution of complex scheduling problems have evolved out of work on the daily allocation and scheduling of Tactical Air Force resources. A generalized, formal model of these applied techniques is being developed. It is called JIGSAW by analogy with the multi-agent, constructive process used when solving jigsaw puzzles. JIGSAW begins from this analogy and extends it by propagating local preferences into global statistics that dynamically influence the value and variable ordering decisions. The statistical projections also apply to abstract resources and time periods--allowing more opportunities to find a successful variable ordering by reserving abstract resources and deferring the choice of a specific resource or time period. Author

**N93-18690*#** Fraunhofer Inst. for Material Flow and Logistics, Dortmund (Germany).

**A HYBRID JOB-SHOP SCHEDULING SYSTEM**

Bernd Hellingrath, Peter Robbach, Fahid Bayat-Sarmadi, and Andreas Marx *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 145-149 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

The intention of the scheduling system developed at the Fraunhofer-Institute for Material Flow and Logistics is the support of a scheduler working in a job-shop. Due to the existing requirements for a job-shop scheduling system the usage of flexible knowledge representation and processing techniques is necessary. Within this system the attempt was made to combine the advantages of symbolic AI-techniques with those of neural networks. Author

**N93-18691*#** Politecnico di Milano (Italy).

**PREDIT: A TEMPORAL PREDICTIVE FRAMEWORK FOR SCHEDULING SYSTEMS**

E. Paolucci, E. Patriarca, M. Sem, and G. Gini *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 150-154 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

Scheduling can be formalized as a Constraint Satisfaction Problem (CSP). Within this framework activities belonging to a plan are interconnected via temporal constraints that account for slack among them. Temporal representation must include methods for constraints propagation and provide a logic for symbolic and numerical deductions. In this paper we describe a support framework for opportunistic reasoning in constraint directed scheduling. In order to focus the attention of an incremental scheduler on critical problem aspects, some discrete temporal indexes are presented. They are also useful for the prediction of the degree of resources contention. The predictive method expressed through our indexes can be seen as a Knowledge Source for an opportunistic scheduler with a blackboard architecture. Author

**N93-18692*#** Boeing Aerospace Co., Kennedy Space Center, FL. Advanced Computing Technologies Group.

**TIME MANAGEMENT SITUATION ASSESSMENT (TMSA)**

Michael B. Richardson and Mark J. Ricci *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 155-159 Sponsored by NASA. Kennedy Space Center (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

TMSA is a concept prototype developed to support NASA Test Directors (NTDs) in schedule execution monitoring during the later stages of a Shuttle countdown. The program detects qualitative and quantitative constraint violations in near real-time. The next version will support incremental rescheduling and reason over a substantially larger number of scheduled events. Author

**N93-18693*#** Edinburgh Univ. (Scotland). Artificial Intelligence Applications Inst.

**CONSTRAINT MONITORING IN TOSCA**

Howard Beck *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 160-165 Sponsored by Hitachi Ltd. (For primary document see N93-18659 06-63)

Avail: CASI HC A02/MF A02

The Job-Shop Scheduling Problem (JSSP) deals with the allocation of resources over time to factory operations. Allocations are subject to various constraints (e.g., production precedence relationships, factory capacity constraints, and limits on the allowable number of machine setups) which must be satisfied for a schedule to be valid. The identification of constraint violations and the monitoring of constraint threats plays a vital role in schedule generation in terms of the following: (1) directing the scheduling process; and (2) informing scheduling decisions. This paper describes a general mechanism for identifying constraint violations and monitoring threats to the satisfaction of constraints throughout schedule generation. Author

**N93-18694*#** SRI International Corp., Menlo Park, CA.

**SOCAP: LESSONS LEARNED IN APPLYING SIPE-2 TO THE MILITARY OPERATIONS CRISIS ACTION PLANNING DOMAIN**

Roberto Desimone *In* NASA. Ames Research Center, Working Notes from the 1992 AAAI Spring Symposium on Practical Approaches to Scheduling and Planning May 1992 p 166-169 (For primary document see N93-18659 06-63)

Avail: CASI HC A01/MF A02

This report describes work funded under the DARPA Planning and Scheduling Initiative that led to the development of SOCAP (System for Operations Crisis Action Planning). In particular, it describes lessons learned in applying SIPE-2, the underlying AI planning technology within SOCAP, to the domain of military operations deliberate and crisis action planning. SOCAP was demonstrated at the U.S. Central Command and at the Pentagon in early 1992. A more detailed report about the lessons learned is currently being prepared. This report was presented during one of the panel discussions on 'The Relevance of Scheduling to AI Planning Systems.' Author

**N93-18882*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

**DEVELOPMENT OF AN hp-VERSION FINITE ELEMENT METHOD FOR COMPUTATIONAL OPTIMAL CONTROL Final Report, 22 Apr. 1992 - 21 Feb. 1993**

Dewey H. Hodges and Michael S. Warner 1993 12 p

(Grant NAG1-1435)

(NASA-CR-192220; NAS 1.26:192220) Avail: CASI HC A03/MF A01

The purpose of this research effort was to begin the study of the application of hp-version finite elements to the numerical solution of optimal control problems. Under NAG-939, the hybrid MACSYMA/FORTRAN code GENCODE was developed which utilized h-version finite elements to successfully approximate solutions to a wide class of optimal control problems. In that code the means for improvement of the solution was the refinement of the time-discretization mesh. With the extension to hp-version finite elements, the degrees of freedom include both nodal values and extra interior values associated with the unknown states, co-states, and controls, the number of which depends on the order of the shape functions in each element. One possible drawback is the increased computational effort within each element required in implementing hp-version finite elements. We are trying to determine whether this computational effort is sufficiently offset by the reduction in the number of time elements used and improved Newton-Raphson convergence so as to be useful in solving

optimal control problems in real time. Because certain of the element interior unknowns can be eliminated at the element level by solving a small set of nonlinear algebraic equations in which the nodal values are taken as given, the scheme may turn out to be especially powerful in a parallel computing environment. A different processor could be assigned to each element. The number of processors, strictly speaking, is not required to be any larger than the number of sub-regions which are free of discontinuities of any kind. Author

**N93-18893#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**AN INTELLIGENT REAL-TIME SYSTEM ARCHITECTURE IMPLEMENTED IN Ada M.S. Thesis**

Michael A. Whelan Dec. 1992 181 p

(AD-A259002; AFIT/GCE/ENG/92D-12) Avail: CASI HC A09/MF A02

Conventional real-time systems are fully deterministic allowing for off-line, optimal, task scheduling under all circumstances. Real-time intelligent systems add non-deterministic task execution times and non-deterministic task sets for scheduling purposes. Non-deterministic task sets force intelligent real-time systems to trade-off execution time with solution quality during run-time and perform dynamic task scheduling. Four basic design considerations addressing those tradeoffs have been identified: control reasoning, focus of attention, parallelism, and algorithm efficacy. Non-real-time intelligent systems contain an environment sensor, a model of the environment, a reasoning process, and a large collection of procedural processes. Real-time intelligent systems add to these a model of the real-time system's behavior, and a real-time task scheduler. In addition, the reasoning process is augmented with a metaplanner to reason about timing issues using the system's behavioral model. Additionally, real-time deadlines force the inclusion of pluralistic solution methods in the intelligent system to allow multiple responses ranging from reactive to fully reasoned and calculated. This research presents an architecture capable of meeting real-time performance goals with on-line scheduling of tasks. GRA

**N93-19018*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH. Dept. of Mechanical Engineering.

**REAL-TIME DIAGNOSTICS FOR A REUSABLE ROCKET ENGINE**

T. H. Guo, W. Merrill, and A. Duyar (Florida Atlantic Univ., Boca Raton.) Aug. 1992 14 p

(RTOP 582-01-41)

(NASA-TM-105792; E-7222; NAS 1.15:105792) Avail: CASI HC A03/MF A01

A hierarchical, decentralized diagnostic system is proposed for the Real-Time Diagnostic System component of the Intelligent Control System (ICS) for reusable rocket engines. The proposed diagnostic system has three layers of information processing: condition monitoring, fault mode detection, and expert system diagnostics. The condition monitoring layer is the first level of signal processing. Here, important features of the sensor data are extracted. These processed data are then used by the higher level fault mode detection layer to do preliminary diagnosis on potential faults at the component level. Because of the closely coupled nature of the rocket engine propulsion system components, it is expected that a given engine condition may trigger more than one fault mode detector. Expert knowledge is needed to resolve the conflicting reports from the various failure mode detectors. This is the function of the diagnostic expert layer. Here, the heuristic nature of this decision process makes it desirable to use an expert system approach. Implementation of the real-time diagnostic system described above requires a wide spectrum of information processing capability. Generally, in the condition monitoring layer, fast data processing is often needed for feature extraction and signal conditioning. This is usually followed by some detection logic to determine the selected faults on the component level. Three different techniques are used to attack different fault detection problems in the NASA LeRC ICS testbed simulation. The first technique employed is the neural network application for real-time sensor validation which includes failure detection, isolation, and accommodation. The second approach demonstrated is the model-based fault diagnosis system using on-line parameter identification. Besides these model based diagnostic schemes, there are still many failure modes which need to be diagnosed by the heuristic expert knowledge. The heuristic expert knowledge is implemented using a real-time expert system tool called G2 by Gensym Corp. Finally, the distributed diagnostic system requires another level of intelligence to oversee the fault mode reports generated by component fault detectors. The decision making at this level can best be done using a rule-based expert system. This level of expert knowledge is also implemented using G2. Author

**N93-19024*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**NUMERICAL CONTROL FABRICATION TECHNIQUE FOR DYNAMIC COMPOSITE MODELS Patent Application**

John B. Kovtun, inventor (to NASA) 29 Jan. 1991 11 p

(NASA-Case-LAR-14004-1; NAS 1.71:LAR-14004-1; US-Patent-Appl-SN-647097) Avail: CASI HC A03/MF A01

In a method of fabricating an article such as a dynamic model or a part thereof, a computer-driven machining means, such as a numerically controlled machine, is used to cut a core material such as a rigid foam into a desired shape and to a size specification that is slightly smaller than the final size desired to the article. Alternating layers of a polymer resin such as polyester and a reinforcing fabric such as fiberglass cloth are then applied to the surface of the core material, causing a build-up of layers of polymer resin and reinforcing fabric to a point at which the item being fabricated is oversized from that desired. Finally, a computer-driven machining means is used to cut the article being fabricated to exact size and shape specifications, leaving a desired thickness of reinforcing material. NASA

**N93-19031** Carleton Univ., Ottawa (Ontario).

**ADAPTIVE CONTROL OF ROBOTIC MANIPULATORS Ph.D. Thesis**

Richard Gourdeau 1990 200 p

Avail: Univ. Microfilms Order No. DANN68904

This work presents a new adaptive motion control scheme for robotic manipulators. This is an adaptive computed torque method (CTM) that requires only position measurements. These measurements and the input torques are used in an extended Kalman filter (EKF) to estimate the inertial parameters of the full nonlinear robot model as well as the joint positions and velocities. These estimates are used by the CTM to generate the input torques. This combination of the EKF and the CTM is shown to result in a stable adaptive control scheme. The theory behind Kalman filtering provides clear guidelines on the selection of the design parameters for the controller when noise is present. Simulations illustrate the performance of this scheme and demonstrate its noise rejection properties. Experimental results with a two-degree-of-freedom direct-drive robot show the efficiency and the applicability of the scheme. Also, a review of the existing adaptive controller schemes is made and these are compared to the new scheme using simulations in both deterministic and stochastic contexts. Optimal path planning for point-to-point motion is also treated. Dissert. Abstr.

**N93-19045** Iowa Univ., Iowa City.

**IMPEDANCE CONTROL DESIGN FOR ROBOT TASKS INVOLVING FREE AND CONTACT MOTION Ph.D. Thesis**

Shih-Tin George Lin 1992 134 p

Avail: Univ. Microfilms Order No. DA9235871

Robot motion can be classified into free and contact motion. A position controller is required for free motion and a position and force controller is required for contact motion. In this thesis, the manipulator task is assumed to entail both free and contact motion, a controller design strategy is proposed for such a task. Position control is first developed in free motion. Then, using impedance control, force control is added through the contact force feedback loop. A compensator in this feedback loop helps to reach the target impedance when the end-effector is in contact with the environment. A wrist force sensor is used to detect contact forces. Since the force sensor signal also contains inertial forces, a Kalman filter is used to extract contact force from the signal. When compliant motion control is applied with the computed torque method, an accurate dynamic model of the manipulator and environment is required. This thesis presents a method for estimating the inertial parameters of a rigid body load and the unknown parameters of the constraint environment. The inertial parameters include the mass, center of gravity, and moment of inertia. The unknown parameters of the constraint environment consist of environmental stiffness and the geometric parameters of the constraint surface. The identification equation is written in the Newton-Euler formulation with the assumption that joint information (position, velocity, and acceleration) and force sensor output are available. Since the identification equation is

nonlinear in terms of the unknown parameters of the environment, the extended Kalman filter is used to produce an optimal estimation.
Dissert. Abstr.

**N93-19046** Pennsylvania Univ., Philadelphia.
**TELEPROGRAMMING: REMOTE SITE ROBOT TASK EXECUTION Ph.D. Thesis**
Thomas Stewart Lindsay 1992 107 p
Avail: Univ. Microfilms Order No. DA9235172

This dissertation describes a remote site robot workcell for teleoperation with communication delays on the order of 20 seconds. In these situations, direct teleoperation becomes impossible due to the delays in visual and force feedback. Teleprogramming has been developed in order to overcome this problem. An integral part of teleprogramming is a semi-autonomous remote site robot system. The remote system is composed of a robot manipulator, sensors, controlling computer, and manipulator tools. The constraints on the remote site system and the amount of autonomy needed are defined partially by the teleprogramming system and partially by the needs of the remote system. Development of the remote site system for teleprogramming evokes some pertinent research issues: low level manipulator control, semi-autonomous command execution, and remote site tool usage. Low level manipulator control is based on a hybrid control scheme using wrist-based sensory feedback. Implementation of this control is presented and problems related to controlling the manipulator in an arbitrary frame are investigated. High level commands are executed at the remote site in small autonomous steps. Implementation of tolerance checks and guarded moves are presented, including error detection and the detection of motion termination conditions in a partially known environment. Power tools introduce redundant degrees of freedom into the manipulator/tool system. To control this redundant system, the tool is actively controlled in its natural degree of freedom and the corresponding degree of freedom in the manipulator becomes passive. Feedback for the manipulator/tool system is supplied by the wrist-based sensor. Two examples of sensing and control for tools are presented. This research has resulted in the development of a remote site system for teleprogramming. The remote system, however, is both time-delay and input independent. The characteristics of the system, including the compliance, flexibility, and semi-autonomity, are useful to a wide variety of robotics applications, including manufacturing and direct teleoperation. Dissert. Abstr.

**N93-19345*#** Rensselaer Polytechnic Inst., Troy, NY. Center for Intelligent Robotic Systems for Space Exploration.
**AN OPTIMAL CONTROL STRATEGY FOR COLLISION AVOIDANCE OF MOBILE ROBOTS IN NON-STATIONARY ENVIRONMENTS**
K. J. Kyriakopoulos and G. N. Saridis Feb. 1991 18 p
(Grant NAGw-1333)
(NASA-CR-191868; NAS 1.26:191868; CIRSSE-83) Avail: CASI HC A03/MF A01

An optimal control formulation of the problem of collision avoidance of mobile robots in environments containing moving obstacles is presented. Collision avoidance is guaranteed if the minimum distance between the robot and the objects is nonzero. A nominal trajectory is assumed to be known from off-line planning. The main idea is to change the velocity along the nominal trajectory so that collisions are avoided. Furthermore, time consistency with the nominal plan is desirable. A numerical solution of the optimization problem is obtained. Simulation results verify the value of the proposed strategy. Author

**N93-19361*#** Rensselaer Polytechnic Inst., Troy, NY. Center for Intelligent Robotic Systems for Space Exploration.
**INERTIAL-SPACE DISTURBANCE REJECTION FOR ROBOTIC MANIPULATORS**
Kevin Holt Nov. 1992 110 p
(Grant NAGw-1333)
(NASA-CR-191867; NAS 1.26:191867; CIRSSE-130) Copyright Avail: CASI HC A06/MF A02

The disturbance rejection control problem for a 6-DOF (degree of freedom) PUMA manipulator mounted on a 3-DOF platform is investigated. A control algorithm is designed to track the desired position and attitude of the end-effector in inertial space, subject to unknown disturbances in the platform axes. Conditions for the stability of the closed-loop system are derived. The performance of the controller is compared for step, sinusoidal, and random disturbances in the platform rotational axis and in the neighborhood of kinematic singularities. Author

**N93-19362*#** Rensselaer Polytechnic Inst., Troy, NY. Center for Intelligent Robotic Systems for Space Exploration.
**A SAFETY-BASED DECISION MAKING ARCHITECTURE FOR AUTONOMOUS SYSTEMS**
Joseph C. Musto and L. K. Lauderbaugh 31 Jul. 1991 20 p
(Grant NAGw-1333)
(NASA-CR-191864; NAS 1.26:191864; CIRSSE-98) Avail: CASI HC A03/MF A01

Engineering systems designed specifically for space applications often exhibit a high level of autonomy in the control and decision-making architecture. As the level of autonomy increases, more emphasis must be placed on assimilating the safety functions normally executed at the hardware level or by human supervisors into the control architecture of the system. The development of a decision-making structure which utilizes information on system safety is detailed. A quantitative measure of system safety, called the safety self-information, is defined. This measure is analogous to the reliability self-information defined by McInroy and Saridis, but includes weighting of task constraints to provide a measure of both reliability and cost. An example is presented in which the safety self-information is used as a decision criterion in a mobile robot controller. The safety self-information is shown to be consistent with the entropy-based Theory of Intelligent Machines defined by Saridis. Author

**N93-19640#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**UNIFIED APPROACH FOR COMPUTER VISION PROBLEMS: MATHEMATICAL MORPHOLOGY [UMA ABORDAGEM UNIFICADA PARA PROBLEMAS DE VISAO COMPUTACIONAL: A MORFOLOGIA MATEMATICA]**
Junior Barrera Jul. 1992 253 p In PORTUGESE
(INPE-5391-TAE/012) Avail: CASI HC A12/MF A03

The concept of a Morphological Language (ML) is defined: a finite number of complete lattices; the operators of infimum and supremum for each of these lattices; and the mappings of erosion, dilation, anti-erosion, and anti-dilation inside each lattice as well as between different lattices. The implementation of a ML is called a Morphological Machine (MMC). A particular MMC was defined and used to solve two problems in Computer Vision: restoration of the stripe effect on images of the satellite SPOT; and a study of cell proliferation by the analysis of microscopic images of tissue samples of AIDS patients. It is proved that an ML can describe any mapping between complete lattices by presenting two canonic decompositions. The proposed decompositions are obtained by introducing the concept of Galois connection. The definitions of sup-generator mapping, kernel and basis, inside the domain of complete lattices, are given, The decompositions are built by analyzing the kernel and can be simplified from the basis. The results are specialized to the cases of inf-separable, increasing and decreasing mappings as well as to lattices which have a sup-generating family. The decompositions presented are dual. Some examples, including the case of Boolean function simplification, illustrate the key concepts and the decomposition expressions. Author

**N93-19823#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**NATURAL SELECTION AND PARTICLE PHYSICS: A THRUST FOR ARTIFICIAL INTELLIGENCE RESEARCH [SELECAO NATURAL E FISICA DE PARTICULAS: UMA DIRECAO DE PESQUISA EM INTELIGENCIA ARTIFICIAL]**
Guilherme Bittencourt Dec. 1991 15 p In PORTUGESE
(INPE-5335-PRE/1734) Avail: CASI HC A03/MF A01

This article presents a proposal for application of the principles of natural selection and particle physics to orient research in artificial intelligence. An elementary model developed in accordance with this proposal is also presented. Author

**N93-19865#** Chicago Univ., IL.
**CASE-BASED REASONING FOR REAL-TIME PROBLEM SOLVING Final Report, 1 Jan. 1991 - 30 Jun. 1992**
Kristian Hammond, Christopher Owens, and Charles Martin 1 Oct. 1992

30 p
(Grant AF-AFOSR-0112-91)
(AD-A258697; AFOSR-92-1022TR) Avail: CASI HC A03/MF A01

This document summarizes the University of Chicago Artificial Intelligence laboratory's work on applying case-based methods to intelligent real-time problem solving. An approach to problem solving involving the storage, retrieval, adaptation, and re-use of successful strategies is outlined. The report describes work on an overall control architecture, on methodological issues in the development of representation vocabularies, and on memory organization for efficient storage and retrieval of cases. Work on six projects is described including work on robot planning, the dynamic repair of transportation schedules, multi-agent cooperative planning, case-based design, and active perception. The result of this work is a model of planning and execution that handles the complexity and instability of a dynamic, real-time environment by making use of known plans stored in memory. GRA

**N93-18502#** Aerospace Corp., El Segundo, CA. Electronics and Sensors Div.
**ARTIFICIAL NEURAL NETWORKS APPLICATION SIMULATOR**
R. J. Talbot, T. C. Le, R. P. Ma, K. Tsai, W. C. Krenz, and H. S. Gobreial *In its* Aerospace Sponsored Research 1 Dec. 1991 p 141-146 (For primary document see N93-18459 06-99)
Avail: CASI HC A02/MF A02

**N93-18840*#** Florida Univ., Gainesville.
**A DARWINIAN APPROACH TO CONTROL-STRUCTURE DESIGN**
David C. Zimmerman *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 303-314 (For primary document see N93-18818 06-18)
(Grant NAG1-1017)
Avail: CASI HC A03/MF A04

## 64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

**N93-17825#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**SHAVRUKOV'S THEOREM ON THE SUBALGEBRAS OF DIAGONALIZABLE ALGEBRAS FOR THEORIES CONTAINING I(DELTA(SUB 0)) + EXP**
Domenico Zambella Aug. 1992 16 p
(ML-92-05; ETN-93-93095) Avail: CASI HC A03/MF A01

Shavrukov's study of subalgebras of diagonalizable algebras of theories of arithmetic is addressed. A study aimed at showing that his results extend to weaker theories (namely to theories containing I(delta(sub 0))+exp) is presented. ESA

**N93-17826#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**THE LAMBEK CALCULUS ENRICHED WITH ADDITIONAL CONNECTIVES**
Makoto Kanazawa (Stanford Univ., CA.) Aug. 1991 27 p
(LP-91-04; ETN-93-93096) Avail: CASI HC A03/MF A01

Certain logically natural extensions of the Lambek calculus, which have analogs of conjunction and disjunction, are studied. The Lambek calculus, which underlies a flexible version of categorical grammar, is a special kind of implicational logic, with its slashes corresponding to logical implication. Viewed from this perspective, it makes sense to add other connectives to it, for example, those corresponding to conjunction and disjunction in more standard logics. Some of the formal properties of this enrichment are investigated, especially with respect to the recognizing power of the resulting extended categorical grammars. ESA

**N93-17828#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**CATEGORICAL GRAMMAR AND NATURAL REASONING**
Victor SanchezValencia Oct. 1991 47 p
(LP-91-08; ETN-93-93100) Avail: CASI HC A03/MF A01

Natural logic, a system of reasoning whose vehicles of inference ('logical forms') are in close accord with natural language, is described. The claim is made that an adequate local proof system for natural language is possible. The aim is to show that there is no opposition between a semantical and a proof theoretical approach to natural reasoning: the proof system begins where the semantics leaves off. This assertion has not only a systematical value but also a heuristic one. The empirical strength of Categorical Natural Logic (CNL) is demonstrated by applying it to several standard examples of natural reasoning. The architecture of CNL described involves the principles of monotonicity, discourse referent introduction, substitution of anaphora, and generalized Boolean coordination. Prerequisites for these principles are shown to be: a system of monotonicity marking, a system of wide scope marking, a system of anamorphic marking, and a general definition of coordination. ESA

**N93-17832#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**QUANTIFIERS INTO THE WORLD OF TYPES**
Johan vanBenthem Aug. 1992 21 p Revised Submitted for publication
(LP-92-09; ETN-93-93109) Avail: CASI HC A03/MF A01

The 'interaction' between the existing notions in quantification and their more general linguistic and logical environment is addressed. Special semantic properties and general phenomena are discussed and generalized quantifiers in Lambda calculus are shown. First order predicate logic is addressed as a point of departure. Axiomatizing inference and the characterization of general monotinicity are addressed. The general linguistics environment of generalized quantifiers is shown to be of interest as such, and is shown to raise unresolved questions concerning logical type theory. Other general mechanisms are concluded as needing investigation, in particular various connections between quantification and the dynamics of interpretation and information flow. ESA

**N93-17835#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.
**SHORTEST PATHS OF BOUNDED CURVATURE IN THE PLANE**
Jean-Daniel Boissonnat, Andre Cerezo (Nice Univ., France ), and Juliette Leblond Jul. 1991 21 p
(INRIA-RR-1503; ETN-93-93366) Avail: CASI HC A03/MF A01

Given two oriented points on the plane, the shortest paths of bounded curvature joining them are determined and computed. This problem was solved recently, by Dubins in the no-cusp case, and by Reeds and Shepp otherwise. A solution based on the minimum principle of Pontryagin is proposed. The approach simplifies the proofs and makes clear the global or local nature of the results. ESA

**N93-17839#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
**A SIMPLIFIED PROOF OF TOYAMA'S THEOREM**
Jan Willem Klop (Vrije Univ., Amsterdam, Netherlands ), Aart Middeldorp, Yoshihito Toyama (Nippon Telegraph and Telephone Public Corp., Kyoto, Japan ), and Roel C. deVrijer (Vrije Univ., Amsterdam, Netherlands ) Dec. 1991 12 p Sponsored in part by EEC; Netherlands Organization for Scientific Organization; Vrije Univ., Amsterdam, Netherlands; Katholieke Univ., Nijmegen, Netherlands
(CWI-CS-R9156; ETN-92-92497) Copyright Avail: CASI HC A03/MF A01

A simple proof of a result of Toyama which states that the disjoint unions of confluent term rewriting systems are confluent is presented. The essential term rewriting background is reviewed and some specific notations concerning disjoint sums are introduced. The proof is given in three distinct steps: presentation, confluence of inner preserved terms, and modularity of confluence. ESA

**N93-17842#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**A BIBLIOGRAPHY OF THE QUALITATIVE THEORY OF QUADRATIC SYSTEMS OF DIFFERENTIAL EQUATIONS IN THE PLANE**
J. W. Reyn 1992 223 p
(Rept-92-17; ETN-93-93111) Copyright Avail: CASI HC A10/MF A03

The bibliography presented has the following goal in mind: that the

results of the qualitative theory of quadratic systems of differential equations should eventually lead to the possibility of making a complete collection of all possible phase portraits of quadratic systems, preferably with each phase portrait having the corresponding values of the coefficients a(sub ij) and b(sub ij). Only references which contain results on quadratic systems are listed and completeness is aimed at though probably not attained. ESA

**N93-17843#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**A Q-ANALOGUE OF THE WRONSKIAN AND A SECOND SOLUTION OF THE HAHN-EXTON Q-BESSEL DIFFERENCE EQUATION**

R. F. Swarttouw and H. G. Meijer 1992 16 p

(Rept-92-18; ETN-93-93112) Copyright Avail: CASI HC A03/MF A01

A study on the theory necessary to give q extensions of the solutions of difference equations and their mutual relations of the Bessel differential equation is presented. A second solution of the q difference equation of the Hahn-Exton q Bessel function, corresponding to the classical Y(sub nu)(x) is found. A q extension of the Wronskian is introduced to determine that the two solutions form a fundamental set. ESA

**N93-17844#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**PRECONDITIONED CONJUGATE GRADIENT TECHNIQUES FOR THE SOLUTION OF TIME-DEPENDENT DIFFERENTIAL EQUATIONS**

K. Dekker 1992 24 p Presented at 5th International Conference on Scientific Computing, Benin City, Benin, 30 Jan. 1992

(Rept-92-19; ETN-93-93113) Copyright Avail: CASI HC A03/MF A01

The conjugate gradient method for the solution of symmetric systems, and the conjugate gradient squared method for unsymmetric systems, are considered. Application of the method of lines to partial differential equations leads to very large, sparse systems of ordinary differential equations, which are usually stiff. Implicit Runge-Kutta methods for the time integration of these systems, and the use of iterative methods for the solution of the resulting linear systems, are considered. The effect of preconditioners, and their performance on vector and parallel computers is discussed. Some results for iterative methods applied to the incompressible Navier-Stokes equation are presented. ESA

**N93-17845#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**AN INTRINSIC CONSTRUCTION OF THE ALGEBRA OF QUATERNIONS**

J. E. Mebius 1992 17 p

(Rept-92-31; ETN-93-93123) Copyright Avail: CASI HC A03/MF A01

A construction of the algebra of quaternions from first principles of real linear algebra while using specific vector space bases as little as possible is presented. The theory of quaternions is developed from the departure point of general elementary theory of groups, finite dimensional real inner product spaces, and algebras. A coordinate independent development in two main steps, namely a coordinate independent definition of the outer product in three dimensional real vector space, and a definition of the quaternions, using the inner and outer product in three dimensional vector space is given. ESA

**N93-17861#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**STRUCTURAL SIMULATION COUPLING FOR TRANSIENT ANALYSIS M.S. Thesis**

Howard T. Clark May 1992 165 p

(AD-A258192; AFIT/CI/CIA-92/101) Avail: CASI HC A08/MF A02

Analysis of the transient time response of many modern engineering systems requires simulation by means of direct time integration of sets of coupled-field equations. In the past, the simulation of such coupled problems has created difficulties which are not seen in analogous singlefield problems. Perhaps the most important of these difficulties is the fact that existing engineering analysis packages have been oriented to solving only single-field problems. This suggests one particularly attractive option: the use of existing, single-field analysis software while imposing certain modular requirements. If modularity can be maintained, direct integration of the equations can proceed by sequential or parallel operation of the separate analyzers. This research develops the theory by which the numerical simulations of two or more separate fields may be combined to solve the coupled-field problem. This theory allows simulations to be used with little or no change by considering the constraints that provide for field coupling. The development takes into account the various numerical methods which may be used by individual simulations to solve their separate problems. Above all, this paper does not seek to suggest that simulation coupling is the best or foremost simulation methodology available, merely that it is a viable and cost saving alternative to solving the larger, more involved coupled-field problem. The specific discipline of focus will be multibody dynamics. The goal is to show that it is possible to couple multiple single body dynamic analysis packages and come up with solutions comparable to the full multibody dynamic case. GRA

**N93-17868#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.

**FEASIBLE INTERPRETABILITY**

Rineke Verbrugge Oct. 1991 32 p Sponsored by Netherlands Organization for Scientific Research

(ML-91-11; ETN-93-93089) Avail: CASI HC A03/MF A01

A concept of interpretability called feasible interpretability, in which the complexity of the interpretation is bounded in a certain way, is investigated. In PA (Peani Arithmetic), or even in I(Delta(sub 0)) + EXP, the concept of feasible interpretability can be defined. Informally stated, U feasibly interprets V iff: for some interpretation, U proves the interpretations of all axioms of V by proofs with Goedel numbers of length polynomial in the length of the Goedel numbers of those axioms. Here both U and V are Sigma(sup b)(sub 1) axiomatized theories. Many interpretations encountered in every day mathematics (e.g., the interpretation of Peano arithmetic into ZF) are feasible. However, by fixed point constructions theories can be found that are interpretable in PA in the usual sense but not by a feasible interpretation. By making polynomial analogs of the usual proofs, the bimodal interpretability logic ILM is shown to be sound for feasible interpretability over the base theory PA. Here, A (triangle pointing to the right) B is translated as PA + A(sup *) (triangle pointing to the right(sub f)) PA + B(sup *), where (sup *) is the translation. In PA, a polynomial version of Orey's theorem for feasible interpretability can be proved. This paves the way for a polynomial adaptation of Berarducci's proof of arithmetical completeness of ILM with respect to PA. Thus, ILM is shown to be arithmetically sound and complete with respect to feasible interpretability over PA. ESA

**N93-17869#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.

**MODAL FRAME CLASSES REVISITED**

Johan vanBenthem Nov. 1991 16 p Submitted for publication

(ML-91-12; ETN-93-93090) Avail: CASI HC A03/MF A01

Notes for a discussion of the interplay between algebraic and model-theoretic methods in modal logic are presented. The removal of the 'algebra' from standard modal results is discussed. The theorem of Goldblatt and Thomason, which transformed the Birkhoff characterization of equational varieties into a structural characterization of modally definable frame classes, is addressed. A model theoretic proof without the algebras is shown. An extension to richer modal formalisms and a specialization to finite frames are given. Ultrafilter extensions are considered. ESA

**N93-17871#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**VECTOR APPROXIMATION PROBLEMS IN GEOMETRIC VECTOR OPTIMIZATION**

K.-H. Elster and R. Elster 1992 34 p

(Rept-92-39; ETN-93-93130) Copyright Avail: CASI HC A03/MF A01

Using a geometric vector inequality, a special case of that inequality which is a basis for treating certain classes of (nonsmooth) vector optimization problems is introduced. The problems are: vector curve fitting problems, l(sup p) vector approximation problems, and vector regression problems. By the introduced geometric vector inequality, dual problems for such special structured vector optimization problems are obtained in a natural way, and can be solved in an efficient manner, since the dual constraints are linear. ESA

**N93-17874#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**PHASE PORTRAITS OF NON DEGENERATE QUADRATIC SYSTEMS WITH FINITE MULTIPLICITY ONE**

J. W. Reyn 1992 39 p
(Rept-92-42; ETN-93-93133) Copyright Avail: CASI HC A03/MF A01

The phase portraits of nondegenerate quadratic systems with a finite multiplicity one are investigated, with the assumption that the system has exactly one finite (elementary) singular point, which must then be real. The division in subclasses, defined on the possible combinations of singular points, as allowed by index and multiplicity considerations, is retained. Use is made of a classification of singular points at infinity, placed at the end of the x axis. ESA

**N93-17879#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 6: Calcul Scientifique, Modelisation et Logiciels Numeriques.

**ANALYSIS OF A MULTISTEP JACOBI MULTIGRID METHOD FOR SOLVING THE EULER EQUATIONS**

Eric Morano and Alain Dervieux Sep. 1991 33 p Sponsored in part by Direction des Recherches, Etudes et Techniques
(INRIA-RR-1506; ETN-93-93367) Avail: CASI HC A03/MF A01

A study on the convergence of Jacobi multistep multigrid methods for solving the steady Euler equations with a monotone, upstream centered scheme for conservations laws (MUSCL) approximation is presented. These methods involve some advantages of local and characteristics time stepping. A four stage Runge-Kutta-Jacobi iterative method is introduced. The main tool is two grid analysis; an analytic study is done for one dimensional case. Experiments are produced in two dimensions for proposing a heuristic rule. A low complexity W cycle is compared to the two grid iteration. ESA

**N93-17913#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.

**COMPARING THE THEORY OF REPRESENTATIONS AND CONSTRUCTING MATHEMATICS**

A. S. Troelstra Jan. 1992 19 p Presented at Computer Science Logic Conference, Bern, Switzerland, Oct. 1991 Submitted for publication
(ML-92-01; ETN-93-93091) Avail: CASI HC A03/MF A01

The analogy between reducibility statements of Weihrauch's theory of representations and theorems of constructive mathematics which can be reformulated as inclusions between sets is explored. Kleene's function realizability is the key to understanding of the analogy, and suggests an alternative way of looking at the theory of reducibilities. ESA

**N93-17914#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.

**ON THE STRUCTURE OF KRIPKE MODELS OF HEYTING ARITHMETIC**

Zoran Markovic (Belgrade Univ., Yugoslavia ) Jul. 1992 12 p Sponsored by Science Fund of Serbia, and Amsterdam Univ.
(ML-92-03; ETN-93-93093) Avail: CASI HC A03/MF A01

Partial answers to the following questions were obtained in referenced papers. Since in Heyting Arithmetic (HA) all atomic formulas are decidable, a Kripke model for HA may be regarded classically as a collection of classical structures for the language of arithmetic, partially ordered by the submodel relation. The obvious question are the following: are these classical structures models of Peano Arithmetic (PA)?; and if a collection of models of PA, partially ordered by the submodel relation, is regarded as a Kripke model, is it a model of HA? Some results in the same direction are presented. In particular, it is proved that the classical structures at the nodes of Kripke model of HA must be models of I(delta(sub 1))(PA(sup -) with induction for provably Delta(sub 1) formulas) and that the relation between these classical structures must be that of a Delta(sub 1) elementary submodel. ESA

**N93-17915#** Amsterdam Univ. (Netherlands). Dept. of Mathematics and Computer Science.

**A MODAL THEORY OF ARROWS: ARROWS LOGICS 1**

Dimiter Vakarelov (Sofia Univ., Bulgaria ) Jul. 1992 28 p
(ML-92-04; ETN-93-93094) Avail: CASI HC A03/MF A01

The notion of Arrow Structure (AS) is introduced as an algebraic version of the notion of directed multigraph. By means of a special kind of a representation theorem for arrow structures, it is shown that the whole information of an AS is contained in the set of its arrows equipped with four binary relations describing the four possibilites for two arrows to have a common point. This makes possible the use of arrow structures as a semantic base for a special polymodal logic called BAL (Basic Arrow Logic). BAL and various kinds of its extensions are used for expressing in a modal setting different properties of arrow structures. Several kinds of completeness theorems for BAL and some other arrow logics are proved, including completeness with respect to classes of finite models. Some open problems and possibilities for further development of the arrow approach are formulated. ESA

**N93-17936#** Naval Postgraduate School, Monterey, CA.

**APPLICATION OF THE TOTAL LEAST SQUARES TECHNIQUE TO FREQUENCY ESTIMATION M.S. Thesis**

Chung-Jung Chiang Sep. 1992 98 p
(AD-A257562) Avail: CASI HC A05/MF A02

Estimating the frequencies of signals in a noisy environment has numerous applications in digital signal processing. In December 1980, Golub and Van Loan proposed a spectral estimator called the Total Least Squares (TLS) technique which is a refinement of the Least Squares (LS) technique. In this thesis, we first describe the origin of the TLS technique and its applications to frequency estimation. Furthermore, we present a numerical implementation for resolving two damped/undamped closely-spaced sinusoidal signals in white noise. Next, we introduce TLS extensions such as the Constrained Total Least Squares (CTLS) technique and the Linear Constraint Total Least Squares (LCTLS) technique. The CTLS addresses the case where the noise components are related and the LCTLS addresses the case where one desires to resolve between two narrowband signals close in frequency, one of which is known. Finally, we present a numerical implementation of the Recursive Total Least Squares (RTLS) technique and apply it to the case of a signal with a fixed frequency together with a signal with a time-varying frequency. GRA

**N93-17946#** Technical Univ. of Denmark, Lyngby. Dept. of Structural Engineering.

**A HARMONIC HALF-SPACE FUNDAMENTAL SOLUTION Ph.D. Thesis**

Ole Vilmann 1991 133 p Sponsored by Otto Moensteds Fond; Thomas B. Thriges Fond; Knud Hoejgaards Fond; and Direktoer Ib Henriksens Fond
(Grant DTRC-16-3950-B)
(Ser-R-271; ISBN-87-7740-072-0; ETN-93-93359) Copyright Avail: CASI HC A07/MF A02

The fundamental solution for a harmonic point force in a half-space of a linear elastic media is established. The fundamental solution consists of the displacements for both a vertical and a horizontal acting point force. The solution is given in cylindrical coordinates. The solution is based on continuous wavesystems through a second order Fourier transform, i.e., a Hankel transform of the horizontal geometrical coordinates. The solution of all displacement components from the wave equation is established as infinite horizontal wavenumber integrals, here inverse Hankel transforms. The solution of each displacement component consists of both an analytical part describing the full space solution and a part describing the influence of the free surface. Accurate numerical schemes for integration of infinite wavenumber integrals are known to be difficult to establish. Therefore, a complex contour integration technique is used to set up an alternative solution method that for certain source-receiver configurations is more efficient than the direct integration method of the infinite wavenumber integral. Two integration methods are shown to be efficient in their complementary parameter domain. An adaptive numerical integration scheme is set up and tested on an infinite wavenumber integral with known analytical solution. The established adaptive numerical integration scheme is used for computation of one fundamental solution displacement component as an example. Possibilities of alternative solution methods and alternative numerical integration schemes and aspects by use of the established fundamental solution in a boundary element method are discussed. ESA

**N93-18186#** Rome Univ. (Italy). Dipt. di Fisica.

**AHARONOV-CASHER EFFECT AND GEOMETRICAL PHASES**

R. Mignani (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 6 Feb. 1991 6 p Submitted for publication
(Preprint-783; ETN-93-92894) Avail: CASI HC A02/MF A01

A study to show that the Aharonov-Casher (AC) phase is a special case of Berry's phases is presented. The original form of Berry's phase, and the gauge invariant Yang phase are used. AC suggested that a neural particle with a magnetic moment experiences a phase shift as it encircles

an infinite line of charge with the particle spin parallel to the charged line. Theoretical contributions to the understanding of the AC effect and experimental evidence of the AC effect are mentioned. An analogous result can be derived for the case of a magnetic or electric dipole in an electromagnetic field. ESA

**N93-18187#** Rome Univ. (Italy). Dipt. di Fisica.
**INFINITE RELATIVISTIC TODA LATTICE: SCATTERING PROBLEM AND CANONICAL STRUCTURE**
S. Cosentino 12 Feb. 1991 19 p Submitted for publication
(Preprint-785; ETN-93-92895) Avail: CASI HC A03/MF A01

The integrability of the infinite relativistic Toda lattice is proved via the inverse scattering technique. The canonical structure of the scattering coordinates is derived in the famework of the matrix formalism. The Hamiltonian system is described and useful changes of variables are given. The equations of motion in the form of a zero curvature condition are presented. A set of variables is constructed via the monodromy matrix for the linear problem associated to the lattice, that linearize the evolution. The change of coordinates is analyzed and its invertibility proved. A way to solve the Cauchy problem is provided. In the framework of the r matrix formalism, the canonical structure of the scattering coordinates is found. As expected, the relativistic Toda is a member of a hierarcy of completely integrable hamiltonian systems, for which a set of action-angle type coordinates can be defined. ESA

**N93-18196#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**TESTING SUPERPERFECTION OF k-TREES**
T. Kloks and H. Bodlaender Feb. 1992 17 p Sponsored by Netherlands Foundation for Computer Science
(Contract EEC-3075)
(RUU-CS-92-09; ETN-93-92809) Avail: CASI HC A03/MF A01

A complete characterization of superperfect 2-trees is given by means of forbidden induced subgraphs. A k-tree is a graph which can be recursively defined as follows. A clique with k + 1 vertices is a k-tree. Given a k-tree with n vertices, a k-tree with n + 1 vertices can be obtained by making a new vertex adjacent to all vertices of a k-clique in the k-tree. For each constant k, a linear time algorithm to test if a k-tree is superperfect is presented. For each constant k, a constant time algorithm to produce a complete characterization of superperfect k-trees is given. A complete list of critical non superperfect 2-trees is presented. This shows the existence of triangulated graphs which are superperfect but not comparability graphs. ESA

**N93-18197#** Rome Univ. (Italy). Dipt. di Fisica.
**YANG PHASE FOR NON-HERMITIAN SYSTEMS AND BIUNITARY TRANSFORMATIONS**
R. Mignani (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 6 Feb. 1991 20 p Submitted for publication
(Preprint-782; ETN-93-92893) Avail: CASI HC A03/MF A01

The invariance of geometrical phases under nonunitary (bicanonical) transformations for quantum systems ruled by non-Hermitian (nH) Hamiltonians is studied. It is shown that the nH generalization of Berry's phase is not invariant under biunitary transformations, while the geometrical plus dynamical phase is invariant. An nH generalization of the Yang phase is defined. The nH Yang phase arises for a system evolution that is neither adiabatic nor cyclic, but reduces to a nH generalization of the Aharonov-Anandan phase for cyclic processes and to the nH Berry phase for both adiabatic and cyclic evolution. The result is found to be invariant indeed under biunitary transformations, as well as all the terms separately which compose the total phase. ESA

**N93-18221#** Limoges Univ. (France).
**SET CONVERGENCES IN NONLINEAR ANALYSIS AND OPTIMIZATION, ABSTRACTS [CONVERGENCES EN ANALYSE MULTIVOQUE AT UNILATERALE (RESUMES DE CONFERENCES)]**
Hedy Attouch and Michel Thera Jun. 1992 120 p In FRENCH
(Contract DAJA-45-92-M-0124)
(AD-A258403; R/D-6876-MS-02) Avail: CASI HC A06/MF A02

The topics covered include the following: Differentiating set-valued maps; Approximation and regularization of arbitrary functions in Hilbert spaces by the Lasry-Lions method; Sum of maximal monotone operators revisited; Convergence of stationary sequences for variational inequalities with maximal monotone operators; A survey of Young measure theory and some applications; Approximation and regularization of arbitrary sets in finite dimension; About the proximal determination of Huber's estimators; Convergence issues in penalty methods; Linear programming for instance; and Subdifferential monotonicity as a characterization of convex functions. GRA

**N93-18237#** Georgia Inst. of Tech., Atlanta. School of Industrial and Systems Engineering.
**LOCATION AND DISTRIBUTION OF LOCAL OPTIMA Final Report**
Donna C. Llewellyn 30 Sep. 1992 112 p
(Contract N00014-89-J-1658)
(AD-A257791) Avail: CASI HC A06/MF A02

In this paper, we present a probabilistic analysis of the time versus solution quality tradeoff of different implementations of a basic sequential edge exchange procedure for a Traveling Salesman Problem. Our TSP will be on a complete graph with edge weights assigned independently and identically according to a Bernoulli distribution. One implementation of the procedure is a generalization of the Lin-Kernighan heuristic. For this implementation, we find asymptotic performance guarantees which decrease geometrically as the depth of the search increases. The basic search procedure may be implemented using a 2-change neighborhood structure. This enables us to find an asymptotic performance guarantee for a 2-opt procedure. GRA

**N93-18246#** Educational Testing Service, Princeton, NJ.
**DIAGNOSING KNOWLEDGE STATES IN ALGEBRA USING THE RULE SPACE MODEL Interim Report, Apr. 1989 - Aug. 1992**
Menucha Birenbaum, Anthony E. Kelly, and Kikumi K. Tatsuoka 1 Oct. 1992 32 p
(Contract N00014-90-J-1307; DA Proj. RR0-4204)
(AD-A257757; ETS-RR-92-57-ONR) Avail: CASI HC A03/MF A01

This paper illustrates the use of rule space as a tool to support cognitive analysis of students' mathematical behavior. The rule space approach is explained and is then used to classify students into one of two methods for solving linear algebraic equations in one unknown and to diagnose their knowledge states in this topic. A 32-item test with open-ended questions was administered to 231 eighth and ninth graders. The following outcomes of the rule space model were presented: (1) a classification of examinees into knowledge states resulting from the two solution approaches at the group level along with individual examples; and (2) tree-diagrams of the transitional relationships among the states for each strategy. Implications for using the feedback provided by the rule space model in the context of instruction and assessment are discussed. GRA

**N93-18302#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**AN ALGORITHM FOR THE SOLUTION OF A TRAVELING SALESMAN PROBLEM TO MINIMIZE THE AVERAGE TIME TO DEMAND SATISFACTION M.S. Thesis**
James P. Ryan Aug. 1992 64 p
(AD-A258301; AFIT/CI/CIA-92-093) Avail: CASI HC A04/MF A01

This paper presents a solution approach for solving a modified traveling salesman problem. In this problem, each city which the salesman must visit contains a quantity of demand (in units) which the salesman must satisfy. The objective of the salesman is to minimize the average time until satisfaction for each unit of demand. The solution approach presented is a branch-and-bound approach in which the total set of feasible tours are broken down into subsets. Lower bounds are calculated for each subset and compared against a known upper bound to determine if this subset can be fathomed or if an improved upper bound has been found. The solution approach presented ensures optimality. A computer code was created and is presented which implements the solution approach developed. GRA

**N93-18315#** Aware, Inc., Cambridge, MA.
**DEVELOP, APPLY AND EVALUATE WAVELET TECHNOLOGY Final Summary Report**
Howard L. Resnikoff 20 Oct. 1992 212 p
(Contract F49620-89-C-0125)
(AD-A258484) Avail: CASI HC A10/MF A03

On this contract, work was completed in three major areas: (1) the

mathematical foundations of wavelet theory; (2) application of wavelets to signal processing; and (3) application of wavelets to partial differential equations. In the area of mathematical foundations, they have investigated both discrete and continuous aspects of wavelet theory. The investigation of the application of wavelets to signal processing, has had two major foci: image compression and computational algorithms. Furthermore, connections between the wavelet and Fourier transforms were investigated and used to describe the characteristics of some fundamental signals in wavelet phase space. Wavelet based numerical methods were applied to the solution of partial differential equations. Specifically, they are used to compare the Wavelet-Galerkin method to standard numerical methods for the numerical solution of the Euler equations of a two-dimensional, incompressible fluid in a Periodic domain, the Biharmonic Helmholtz equation, and the Reduced Wave equation in nonseparable, two-dimensional geometry and the Euler and Navier-Stokes equations in nonseparable, two dimensional geometry. The wavelet methods have significant advantages with regard to stability, accuracy, and rate of convergence. GRA

**N93-18435#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.

**LAMBDA-CALCULI FOR (STRICT) PARALLEL FUNCTIONS [LAMBDA-CALCULS POUR LES FONCTIONS PARALLELES (STRICTES)]**

Gerard Boudol Jan. 1991 60 p Sponsored in part by Commission of the European Communities

(INRIA-RR-1387; ETN-93-92630) Avail: CASI HC A04/MF A01

Two lambda calculi are introduced and they are shown to be expressive for two canonical domains of parallel functions. The first calculus is an enrichment of the lazy, call-by-name lambda calculus with call-by-value abstractions and parallel composition, while in the second the usual call-by-name abstractions are disallowed. The corresponding domains are respectively Abramsky's domain, a lifted function space, and a lifted domain of strict functions. These domains are lattices, and the parallelism is shown to be adequately represented by the join operator, while call-by-value abstractions correspond to strict functions. The proofs of the results rely on a completeness theorem for the logical presentation of the semantics. ESA

**N93-18436#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.

**STUDY AND IMPLEMENTATION OF A SET OF PRIMITIVES FOR CONSTRAINT SATISFACTION IN FINITE DOMAINS [ETUDE ET REALISATION D'UN ENSEMBLE DE PRIMITIVES POUR LA SATISFACTION DE CONTRAINTES EN DOMAINES FINIS]**

Pierre Berlandier Jan. 1991 70 p In FRENCH

(INRIA-RR-1389; ETN-93-92631) Avail: CASI HC A04/MF A01

A survey on the state of the art in the field of constraint satisfaction is presented. Within the framework of n-ary constraints, some techniques that take advantage of the active nature of some constraints, the tree structure of some problems and the exhaustive traversal of the search space, are studied. A module that operates over the LE LISP language to state and solve constraint problems is described. The motivation for writing this module was the integration of constraint satisfaction tools in the SMECI expert system shell. It is implemented using an abstract model for constraints. As a consequence, it is independent from the constraint representation which is handled via functional interface. ESA

**N93-18456#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.

**OUTPUT SENSITIVE CONSTRUCTION OF THE 3D DELAUNAY TRIANGULATION OF CONSTRAINED SETS OF POINTS [ALGORITHME DEPENDANT DE LA SORTIE POUR LA TRIANGULATION DE DELAUNAY 3D D'ENSEMBLES DE POINTS CONSTRAINTS]**

Jean-Daniel Boissonnat, Andre Cerezo (Nice Univ., France ), Olivier Devillers, and Monique Teillaud Apr. 1991 18 p Sponsored in part by Commission of the European Communities

(INRIA-RR-1415; ETN-93-92638) Avail: CASI HC A03/MF A01

Two algorithms to compute the Delaunay triangulation of a set S of n points in three dimensional (3D) space when the points lie on a set P of k planes are presented. If $k = 2$, the algorithm runs in time $O(n \log n + t)$ where t is the size of the output; if k is greater than or equal to 3, the time bound is $O(tk \log n)$. In both cases, the storage is $O(n)$. ESA

**N93-18458#** Sheffield Univ. (England). Dept. of Control Engineering.

**RECONSTRUCTION OF LINEAR AND NONLINEAR CONTINUOUS TIME MODELS FROM DISCRETE TIME SAMPLED-DATA SYSTEMS**

K. M. Tsang (Hong Kong Polytechnic, Kowloon.) and S. A. Billings Sep. 1990 22 p

(RR-406; ETN-92-92765) Avail: CASI HC A03/MF A01

A new approach for identifying continuous time models from discrete time sampled data records is presented. The proposed method involves estimating and validating a discrete time model, linear or nonlinear, based on sampled data records. The discrete time linear and nonlinear frequency response functions are evaluated and the curve is fitted to the frequency response data to yield a continuous time model. No numerical differentiation and integration is involved. Errors introduced by the numerical approximation of differentiation and integration are eliminated. The orthogonal estimator provides information on the model structure and the unknown parameter values for linear and nonlinear continuous time models. The advantage of this approach is that nonlinear differential equation models can be readily computed from discrete time data. ESA

**N93-18594#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.

**ON CORNER AND VERTEX DETECTION [SUR LA DETECTION DES JONCTIONS ET DES POINTS ANGULEUX]**

Gerard Giraudon and Rachid Deriche Jun. 1991 36 p Sponsored in part by Commission of the European Communities

(INRIA-RR-1439; ETN-93-92646) Avail: CASI HC A03/MF A01

An extension of previous work on the problem of the characterization and detection of vertices in real images is presented. An analytical study for a general vertex model that allows better understanding of the behavior of this important feature in the scale-space is addressed. In particular, a trihedral vertex is shown to have two elliptic maxima on extremal constrast surfaces if the contrast is sufficient, and this allows classification of vertices into two classes: 'vertex' and 'vertex as corner'. The corner detection approach previously developed is applied to accurately detect trihedral vertices. A test is executed to make a distinction between vertex and corner among detected features. Several promising experimental results carried out using noisy synthetic and real images including corners and vertices are reported. ESA

**N93-18597#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 5: Traitement du Signal, Automatique et Productique.

**PARTICLE APPROXIMATION FOR FIRST ORDER STOCHASTIC PARTIAL DIFFERENTIAL EQUATIONS [APPROXIMATION PARTICULAIRE POUR LES EQUATIONS AUX DERIVEES PARTIELLES STOCHASTIQUES DU PREMIER ORDRE]**

Patrick Florchinger (Metz Univ., France ) and Francois LeGland Sep. 1991 18 p Presented at NSF-INRIA Workshop on Applied Stochastic Analysis, New Brunswick, NJ, 29 Apr. - 2 May 1991

(Contract DAJA45-90-C-0008)

(INRIA-RR-1502; ETN-93-92660) Avail: CASI HC A03/MF A01

A class of degenerate second order stochastic PDE (Partial Differential Equation) is considered, for which a representation result in terms of stochastic characteristics was proved by Krylov-Rozovskii and Kunita. An example of a stochastic PDE in this class was exhibited in Florchinger-LeGland as the result of a Trotter like product formula for the Zakai equation of diffusion processes observed in correlated noise. Particle approximations are introduced for this class of stochastic PDE, and error estimates are provided which extend the results of Raviart on first order deterministic PDE. ESA

**N93-18612#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.

**FLOW MODELS OF DISTRIBUTED COMPUTATIONS: EVENT STRUCTURES AND NETS [STRUCTURES D'EVENEMENTS ET RESEAUX A FLUX]**

Gerard Boudol and Ilaria Castellani Jul. 1991 38 p Sponsored in part by Commission of the European Communities
(INRIA-RR-1482; ETN-93-92653) Avail: CASI HC A03/MF A01

Flow event structures, which provide an intermediate between prime and stable event structures, are introduced. These three kinds of event structures are abstractly equivalent in that they give concrete presentations for the same kind of domains, namely dI-domains. However, regarded as means of defining families of configurations, these event structures are increasingly more powerful. From this point of view, flow event structures are related to a new kind of Petri nets, called flow nets; for each flow event structure, it is shown that a flow net having the same configurations can be built, a configuration of a net being a set of events firable in sequence, and conversely. This generalizes earlier results that relate prime event structures and occurrence nets. Safe flow nets are shown which correspond to bundle event structures introduced recently. This establishes a strict hierarchy upon the various kinds of event structures: prime, bundle, flow, and stable ones. ESA

**N93-18614#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 2: Calcul Symbolique, Programmation et Genie Logiciel.
**OBSERVING LOCALITIES [SUR L'OBSERVATION DE LA REPARTITION DES PROCESSUS]**
Gerard Boudol, Ilaria Castellani, Matthew Hennessy (Sussex Univ., Brighton, England ), and Astrid Kiehn (Technische Univ., Munich, Germany ) Jul. 1991 40 p Sponsored by Commission of the European Communities
(INRIA-RR-1485; ETN-93-92656) Avail: CASI HC A03/MF A01

A refined version of observation for CCS (Calculus of Communicating Systems) which allows the observer to see the distributed nature of processes is introduced. Using several examples, it is argued that a semantic theory based on such observations is not only intuitive but may also be of use when formalizing the relationship between implementations and specifications. The resulting theory of 'location equivalence' is shown to be very similar to that of bi-simulation equivalence,for example it can be characterized by a simple modal logic. A comparison with distributed bi-simulations is given. ESA

**N93-18653#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 1: Architectures Paralleles, Bases de Donnees, Reseaux et Systemes Distribues.
**DERIVATIVES OF LIKELIHOOD RATIOS AND SMOOTHED PERTURBATION ANALYSIS FOR THE ROUTING PROBLEM [DERIVEES DE RAPPORTS DE VRAISEMBANCE ET ANALYSE DE PERTURBATIONS POUR LE PROBLEME DU ROUTAGE]**
Pierre Bremaud (Centre National de la Recherche Scientifique, Gif-sur-Yvette, France ) and Wei-Bo Gong (Massachusetts Univ., Amherst.) Sep. 1991 27 p
(INRIA-RR-1495; ETN-93-92659) Avail: CASI HC A03/MF A01

Estimates for the gradients of the cycle variables with respect to a thinning parameter in the arrival process of G/G/1 queueing systems are presented. The estimates belong to the category of the likelihood ratio method and smoothed perturbation analysis estimates. In particular, consistent estimates of derivatives of any order on the random or infinite horizon case (stationary and ergodic estimates) are obtained. An approach of applying the obtained estimates to the adaptive routing design is proposed. ESA

**N93-18871*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
**ROBUST STABILITY OF SECOND-ORDER SYSTEMS Semiannual Status Report, 24 Aug. 1992 - 23 Feb. 1993**
C. H. Chuang 23 Feb. 1993 27 p
(Grant NAG1-1397)
(NASA-CR-192246; NAS 1.26:192246) Avail: CASI HC A03/MF A01

This report presents a robust control design using strictly positive realness for second-order dynamic systems. The robust strictly positive real controller allows the system to be stabilized with only acceleration measurements. An important property of this design is that stabilization of the system is independent of the system parameters. The control design connects a virtual system to the given plant. The combined system is positive real regardless of system parameter uncertainty. Then any strictly positive real controllers can be used to achieve robust stability. A spring-mass system example and its computer simulations are presented to demonstrate this controller design. Author

**N93-18886#** Army Research Lab., Adelphi, MD.
**A HIGHER ORDER EXPONENTIAL FUNCTION FOR FITTING NONLINEAR CURVES Final Report**
Henry Rachele, Lisa Manguso, and Neal H. Kilmer Dec. 1992 19 p
(AD-A258431; ARL-MR-24) Avail: CASI HC A03/MF A01

Numerous mathematical methods have evolved over the years for fitting curves that exhibit nonlinear character. In this technical memorandum, the authors present a continuous function, the Rachele/Kilmer (R/K) optical profile function, that was originally configured by R/K to fit model simulated vertical profiles of extinction and backscatter coefficients in very low stratus clouds and subcloud regions. The R/K function fits most of the nonlinear optical profiles so well that the authors were encouraged to investigate its potential for fitting nonlinear curves that were produced by other physical/mathematical models. Results are presented that demonstrate the versatility and power of the R/K function when fitting simulated data from three different models. GRA

**N93-18889#** Air Force Academy, CO.
**AN INTRODUCTION TO THE METHOD OF AVERAGING Final Report**
Carl Edwin Nov. 1992 26 p
(AD-A258990; USAFA-TR-92-6) Avail: CASI HC A03/MF A01

The method of averaging is a powerful tool for the integration of systems of ordinary differential equations which have some rapidly oscillating variables and other slowly oscillating variables. This report bridges the gap from casual acquaintance with the underlying idea to technical reading and application. Three examples are worked in detail. GRA

**N93-18987#** Naval Postgraduate School, Monterey, CA. Dept. of Mathematics.
**INVERSE PROBLEMS FOR ORTHOGONAL MATRICES, TODA FLOWS, AND SIGNAL PROCESSING Technical Report, Jul. - Sep. 1992**
L. Faybusovich, G. S. Ammar, and W. B. Gragg 13 Oct. 1992 8 p
(AD-A258810; NPS-MA-93-001) Avail: CASI HC A02/MF A01

We consider Toda flows induced on the set of orthogonal upper Hessenberg matrices. The explicit formulas for the evolution of Schur parameters are given. GRA

**N93-19008#** Ecole Normale Superieure, Cachan (France). Lab. de Mecanique et Technologie.
**OPTIMIZATION OF THREE DIMENSIONAL MESHES Final Summary Report [OPTIMISATION DE MAILLAGES TRIDIMENSIONNELS]**
P. Ladeveze, P. Marin, and J. P. Pelle 1991 69 p In FRENCH
(Contract DRET-88-224)
(ETN-92-92554) Avail: CASI HC A04/MF A01

A method for the optimization and error evaluation of incompressible and nearly incompressible three dimensional meshes is presented. The error concept and techniques are applied to construct the stress field and the possible displacements controlling the error due to finite element discretization. Available error calculations were extended to commonly used three dimensional incompressible or nearly compressible materials. The method is also extended to the Hermann model, which is adapted to calculations on materials such as propergols. The development is particularly useful for reducing calculation costs. The results were used to test the quality of a finite element method. The parameters to construct optimal meshes are obtained. ESA

**N93-19066#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**EXTENDED LYAPUNOV EXPONENTS FOR SECOND ORDER SYSTEMS M.S. Thesis**
Janice M. Horn Dec. 1992 126 p
(AD-A258838; AFIT/GA/ENY/92D-09) Avail: CASI HC A07/MF A02

It is shown that the concept of the Lyapunov exponent can be extended to include an imaginary part. A numerical technique used to calculate these extended Lyapunov exponents for second order systems is presented. There are two requirements to make this extension possible: the definition of a coordinate frame on the tangent space of the differential equation, and an extension of the classical limit, called the limit of the mean. An

application of the technique to the van der Pol equation for the constant coefficient and periodic coefficient cases is given. The extended Lyapunov exponents found using this technique totally agrees with the eigenvalues for the constant coefficient case. In the periodic coefficient case, not only do the extended Lyapunov exponents agree with the Poincare exponents calculated using standard Floquet theory, they confirm that the imaginary parts of the Poincare exponents are equal to the quotient plus or minus (i(2pi)/tau) where tau is the period of the trajectory. This imaginary part is uncertain when using standard Floquet theory. Additionally, fast Fourier transform (FFT) techniques are used to validate the existence of the extended Lyapunov exponent and the values obtained for its imaginary part. These techniques show that the power spectrum of relative motion is discrete for the trial cases presented, with the fundamental frequency almost exactly equal to the calculated imaginary part of the extended Lyapunov exponent. Coupled with the successful comparison of characteristic exponents for the constant coefficient and periodic coefficient cases, this power spectrum serves to decisively validate the existence of the extended Lyapunov exponent. GRA

**N93-19112#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**IMPROVEMENTS TO LQGI/LTR METHODOLOGY FOR PLANTS WITH LIGHTLY DAMPED OR LOW FREQUENCY POLES M.S. Thesis**
An-Chi Ju Dec. 1992 133 p
(AD-A258841; AFIT/GAE/ENY/92D-14) Avail: CASI HC A07/MF A02

The Linear Quadratic Gaussian/Loop Transfer Recovery (LQG/LTR) design has a tendency to invert the plant's dynamics, which is undesirable if there are plant poles near the imaginary axis. Static Output Feedback (SOF) is applied to reassign plant poles before LQG/LTR is applied. Alternatively, Robust Eigenstructure Assignment (REA) was used to design the target loop transfer function with an ideal eigenstructure to avoid the undesirable cancellations. Both methods were applied to several aircraft design problems. Results showed that the methods can be effectively used so that the LQG/LTR design has improved stability and performance; however, it was found that each method had strengths and weaknesses. GRA

**N93-19468#** California Univ., Berkeley. Lawrence Berkeley Lab.
**ALTERNATIVE FORMULATIONS OF THE LAPLACE TRANSFORM BOUNDARY ELEMENT (LTBE) NUMERICAL METHOD FOR THE SOLUTION OF DIFFUSION-TYPE EQUATIONS**
G. Moridis Mar. 1992 19 p Presented at the 7th International Conference on Boundary Element Technology, Albuquerque, NM, 3-5 Jun. 1992
(Contract DE-AC03-76SF-00098)
(DE92-041172; LBL-32021; CONF-920664-2) Avail: CASI HC A03/MF A01

The Laplace Transform Boundary Element (LTBE) method is a recently introduced numerical method. It is used for the solution of diffusion-type PDE's. It completely eliminates the time dependency of the problem and the need for time discretization, yielding solutions numerical in space and semi-analytical in time. The LTBE solutions are obtained in the Laplace spare. The solutions are then inverted numerically to yield the solution in time. The Stehfest and the DeHoog formulations of LTBE, based on two different inversion algorithms, are investigated. Both formulations produce comparable, extremely accurate solutions. DOE

**N93-19472#** Northwestern Univ., Evanston, IL. Dept. of Mechanical Engineering.
**VARIATIONAL NODAL TRANSPORT METHODS FOR HEXAGONAL AND THREE-DIMENSIONAL GEOMETRIES**
E. E. Lewis Feb. 1992 5 p
(Contract DE-FG02-88ER-12810)
(DE93-002131; DOE/ER-12810/1) Avail: CASI HC A01/MF A01

The properties of the variational nodal method for neutron transport calculations are investigated. The method is generalized for three-dimensional multigroup criticality problems in both hexagonal-z and Cartesian geometries. The method is implemented as part of the Argonne National Laboratory Code DIF3D and is applied to a series of benchmark reactor calculations. Variational nodal methods are compared of nodal transport methods based on both interface-current and discrete ordinate approximations. Model problems are used to examine the effect of running each of the three classes of nodal transport methods on computers with massively parallel architectures. DOE

**N93-18504#** Aerospace Corp., El Segundo, CA. Computer Systems Div.
**WRAPPING MATHEMATICAL TOOLS**
C. A. Landauer, K. L. Bellman, A. H. Bond, G. Chen-Ellis, A. Gillam, R. Lindell, M. T. OBrien, A. E. Quilici, and D. J. Strauss *In its* Aerospace Sponsored Research 1 Dec. 1991 p 149-152 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18505#** Aerospace Corp., El Segundo, CA. Electronics and Sensors Div.
**ADVANCED VECTOR QUANTIZATION TECHNIQUES**
V. D. Vaughn and T. S. Wilkinson *In its* Aerospace Sponsored Research 1 Dec. 1991 p 152-155 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18905*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SELF-DUAL (48,24;12) CODES**
G. Solomon *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 75-79 (For primary document see N93-18897 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A01/MF A03

**N93-18906*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**MORE BOX CODES**
G. Solomon *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 80-82 (For primary document see N93-18897 06-32)
(RTOP 310-30-71-83-02)
Avail: CASI HC A01/MF A03

## 65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

**N93-17902#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**ROBUST MULTIVARIABLE FEEDBACK DESIGN FOR UNCERTAIN LINEAR SYSTEMS Ph.D. Thesis**
Mark C. Crews 1992 223 p
(AD-A258257; AFIT/CI/CIA-92-025D) Avail: CASI HC A10/MF A03

Realistic control strategies must address the inevitable uncertainty which accompanies nominal system descriptions. Even though uncertainty can often be characterized mathematically, effective robust control techniques have been slow to appear. This work investigates robust control methods directed at both the analysis and design of multivariable feedback systems in the presence of system uncertainty. The first part of the thesis examines perturbed interaction from the generalized Nyquist/characteristic locus perspective. This work establishes that, for a given class of uncertainty and a specific class of gain-limited controllers, feedback compensation can be optimally deployed to reduce perturbed interaction. Subsequently, this treatment exploits the geometric eigen-structure embodied in the characteristic locus framework along with the appropriate stationary conditions in order to characterize the worst case uncertainty which produces the largest interaction as measured by the perturbed misalignment angles. Furthermore. the structure of the worst case perturbation has a particularly simple representation which facilitates the determination of the worst case interaction based on simple open-loop quantities. These results together with the previous development of the E-Contour method complete the overall development of the characteristic locus approach as a convenient robust analysis tool. GRA

**N93-17950** ESDU International Ltd., London (England).
**AN INTRODUCTION TO THE STATISTICAL ANALYSIS OF ENGINEERING DATA**
Dec. 1992 22 p
(ESDU-92040; ISBN-0-85679-848-7) Avail: ESDU

ESDU 92040 is directed to making statistical methods of analysis

accessible to engineering users. It summarizes the basic statistical terms and principles involved and discusses techniques most commonly used. It is restricted to consideration of a single random variable and covers fundamental concepts. After discussing the probability of random events and of discrete and continuous random variables it considers measures of location and dispersion and introduces the concept of the standard distribution. Sampling is then explained together with the influence of censoring. Statistical techniques are introduced in terms of the use of tests for goodness-of-fit, point and interval estimation and hypothesis testing. Brief mention is included of distribution-free (non-parametric) techniques and simulation (Monte Carlo) methods. ESDU 91041 covers the analysis of data from the Normal distribution and includes statistical tables. ESDU

**N93-18180#** Naval Postgraduate School, Monterey, CA.
**AN EXAMINATION OF THE PERFORMANCE OF A NATURAL TRUNCATION POINT AND ACCEPTANCE RULE FOR A CURTAILED WALD SEQUENTIAL SAMPLING PLAN WITH BERNOULLI PARAMETERS M.S. Thesis**
Cameron J. Lewis Sep. 1992 128 p
(AD-A257579) Avail: CASI HC A07/MF A02

This paper examines the performance of a proposed truncation and acceptance rule for the Wald Sequential Probability Ratio test for Bernoulli parameters and the rules influence on errors of the first and second kind as well as the average number of items sampled for inspection. The proposed truncation and acceptance rule suggest that there exists a natural truncation point for every Sequential Probability Ratio test such that the desired error probabilities are not exceeded, or that one of the true errors is smaller than desired, and the other will be exceeded by an insignificant amount. A computer program is used to simulate the sampling process and provide estimates of the true values of a plan's Operating Characteristic curve, its average sample number, as well as the probability of implementing the truncation and acceptance rule. Results suggest that truncation and rejection of a lot at the natural truncation point will maintain a plan's desired Operating Characteristic curve. The cases examined also suggest that any modifications to the natural truncation point truncation and acceptance rule may cause an unacceptable deviation from the desired Operating Characteristic curve. Finally, a linear equation was developed which provides an estimate of the upper limit on the probability of implementing a truncation and acceptance rule and that in most cases, this upper limit is less than 0.15. GRA

**N93-18195#** Naval Postgraduate School, Monterey, CA.
**FIXED AND DATA ADAPTIVE KERNELS IN COHEN'S CLASS OF TIME-FREQUENCY DISTRIBUTIONS M.S. Thesis**
Robert E. Parker, Jr. Sep. 1992 87 p
(AD-A257979) Avail: CASI HC A05/MF A01

Estimating the spectra of non-stationary signals represents a difficult challenge. Classical techniques employing the Fourier transform and local stationarity have been employed with limited success. A more promising approach is the use of time-frequency distributions. The majority of useful distributions have been unified under Cohen's class of distributions, a bilinear transformation with an arbitrary, fixed kernel function. The properties of several popular distributions developed from Cohen's class of distribution are examined. The ability of the kernel to suppress spurious cross-terms resulting from the bilinear nature of these distributions is examined along with their characteristics. Distributions employing a fixed kernel usually give good results only for a small class of signals. A data adaptive kernel is also examined which promises to give superior results for a broad class of signals. Results are shown for several test cases employing synthetic analytic signals. GRA

**N93-18508#** Sheffield Univ. (England). Dept. of Automatic Control and Systems Engineering.
**A STRUCTURE DETECTION ALGORITHM FOR NONLINEAR DYNAMIC RATIONAL MODELS**
S. A. Billings and Q. M. Zhu Mar. 1992 34 p
(Grant SERC-GR/F2417-7)
(RR-439; ETN-92-92767) Avail: CASI HC A03/MF A01

A general structure detection and parameter estimation algorithm is derived. The algorithm is to be used in the identification of nonlinear systems which can be approximated by a stochastic nonlinear rational model defined as the ratio of two polynomial expansions of past inputs, outputs, and noise sequences. The algorithm includes an intelligent structure detection module which learns the structure of the model from the input output data. Simulation results are included to illustrate the application of the new algorithms. The study shows that fitting models to data is easy if you know which terms to regress upon. This information is rarely available to the experimenter and a combined intelligent structure detection. The parameter estimation algorithm is presented as one possible solution to this problem for the class of nonlinear rational models. ESA

**N93-18625#** Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France).
**TOOLS OF MODELING, IDENTIFICATION, AND SIGNAL PROCESSING FOR FAULT DIAGNOSIS IN CONTINUOUS-TIME SYSTEMS Ph.D. Thesis - Inst. National des Sciences Appliquees [OUTILS DE MODELISATION, IDENTIFICATION ET TRAITEMENT DU SIGNAL POUR LE DIAGNOSTIC DES DEFAUTS DANS LES SYSTEMES CONTINUS]**
Louay Homssi 1992 177 p In FRENCH
(LAAS-92153; ETN-93-92728) Avail: CASI HC A09/MF A02

Analytical tools for diagnosis of slowly developing faults in continuous time systems are presented. A methodology of diagnosis based on modeling and parametric identification of the supervised system is presented. It has several advantages: richness analysis of the input signal to choose time intervals adequate for identification; detection and localization of internal faults by observing the estimated parameters; and possibility of sensor faults localization. A great deal of the work is for parametric identification of continuous time models: classification of identification methods; presentation, numerical and qualitative comparison of eight identification methods. Several problems related to identification are discussed (continuous time stochastic models, delay, initial conditions and measurements bias, and input richness). Recursive algorithms for the computation of Fourier's coefficients, discrete Fourier transform, and Legendre's coefficients on moving window are established. A package for simulation and identification of continuous time models were implemented in parallel with the work. ESA

**N93-18646#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 1: Architectures Paralleles, Bases de Donnees, Reseaux et Systemes Distribues.
**COMPARISON PROPERTIES OF STOCHASTIC DECISION FREE PETRI NETS [PROPRIETES DE COMPARAISON STOCHASTIQUE DANS LES GRAPHES D'EVENEMENTS ALEATOIRES]**
Francois Baccelli and Zhen Liu May 1991 33 p
(INRIA-RR-1433; ETN-93-92643) Avail: CASI HC A03/MF A01

Stochastic comparison problems arising in the analysis of stochastic decision free Petri nets are addressed. The analysis is based on the evolution equations satisfied by firing times. Various structural properties are obtained including the association of the firing times and their stochastic and convex monotonicity with respect to the holding time sequences and to the initial marking. The association and the stochastic monotonicity properties are extended to the counters using an inversion relation. The counters and the throughput are proved to be stochastically concave in the initial marking provided the holding times are i.i.d. and belong to a subclass of log-concave distribution functions. Various bounds for the asymptotic cycle time and the throughput are then derived from these stochastic ordering results. Results concerning the stochastic and convex monotonicity of the transient and the stationary marking distributions are presented. ESA

**N93-18946#** Stanford Univ., CA. Dept. of Statistics.
**MODELING EXPERT OPINION: LIKELIHOODS UNDER INCOMPLETE PROBABILISTIC SPECIFICATION**
Alan E. Gelfand, Bani K. Mallick, and Dipak K. Dey 9 Dec. 1992 31 p
(Contract N00014-92-J-1264)
(AD-A258775; SU-TR-464) Avail: CASI HC A03/MF A01

Expert opinion is often sought with regard to unknowns in a decision-making setting. Our presumption is that such opinion is elicited as an incomplete probabilistic specification either in the form of probability assignments to fixed intervals or in the form of selected quantiles. We present likelihoods for such specification which arise through random mixtures of Beta distributions. We presume that a supra-Bayesian presides over the opinion collection resulting in the posterior distribution as the

mechanism for pooling opinion. The models are applied to opinion collected regarding points per game for participants in the 1991 NBA championship basketball series. GRA

**N93-18947#** Stanford Univ., CA. Dept. of Statistics.
**MODEL DETERMINATION USING PREDICTIVE DISTRIBUTIONS WITH IMPLEMENTATION VIA SAMPLING-BASED METHODS**
Alan E. Gelfand, Dipak K. Dey, and Hong Chang 4 Dec. 1992 45 p
(Contract N00014-92-J-1264)
(AD-A258777; SU-TR-462) Avail: CASI HC A03/MF A01

Model determination is divided into the issues of model adequacy and model selection. Predictive distributions are used to address both issues. This seems natural since, typically, prediction is a primary purpose for the chosen model. A cross-validation viewpoint is argued. In particular, for a given model, it is proposed to validate conditional predictive distributions arising from single point deletion against observed responses. Sampling based methods are used to carry out required calculations. An example investigates the adequacy of and rather subtle choice between two sigmoidal growth models of the same dimension. GRA

**N93-19445#** Naval Health Research Center, San Diego, CA.
**A CENTRAL LIMIT THEOREM FOR AUTOREGRESSIVE INTEGRATED MOVING AVERAGE PROCESSES Final Report, Jun. - Aug. 1992**
John E. Angus Aug. 1992 14 p
(AD-A258923; NHRC-92-15) Avail: CASI HC A03/MF A01

A modification of the classical compound Poisson process has been shown to be a viable model for describing total claims and compensation costs associated with hazardous material exposure. This model assumes that the successive claim awards form an autoregressive integrated moving average (ARIMA) process. In order to make practical approximations to the distribution of total claim and compensation costs with this model, it is necessary to develop approximations to the distribution of the sum of successive elements from an ARIMA process. In this investigation, a central limit theorem is developed for ARIMA processes, that makes this approximation possible in the case where the number of summands is large. GRA

**N93-19864#** Georgia Inst. of Tech., Atlanta.
**ON THE THEORY OF TURBULENT DYNAMICS Final Report, 1 Mar. 1990 - 30 Sep. 1992**
Ronald F. Fox 30 Sep. 1992 35 p
(Grant AF-AFOSR-0158-90)
(AD-A258695; AFOSR-92-1028TR) Avail: CASI HC A03/MF A01

Acceptance of the discovery of amplification of intrinsic fluctuations by chaotic dynamics has been slow. They have been able to identify several of the mental blocks experienced by others and have successfully clarified their position for some of these people. But it has been a slow process. The principal problem has been that some earlier researchers saw amplification of intrinsic fluctuations in their own work but failed to recognize its significance. These include Robert Graham and B. Huberman. The two conceptual insights they have missed are: (1) such amplification invalidates the contraction of the description from the mesoscopic level to the macroscopic level; and (2) the centrality of the Jacobi matrix in the theory since it connects the magnitude (and sign) of the largest Liapunov exponent with the growth of the fluctuations. The first oversight by others follows from their failure to embed the phenomenon in the context of levels of description. Rather, in their work, they have simply added fluctuations to macroscopic equations and investigated what happens. The second oversight results from not suspecting a connection in the first place. GRA

**N93-19953#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**TOWARD AN OPTIMAL STRATEGY FOR SAMPLING CHAOTIC TIME SERIES USING THE SMALE-WILLIAMS DYNAMICAL SYSTEM M.S. Thesis**
Mark A. Sellers Dec. 1992 108 p
(AD-A258550; AFIT/CI/CIA-92-111) Avail: CASI HC A06/MF A02

Chaotic dynamical systems such as the atmosphere can be characterized by their associated geometrical structures in phase space that are known as strange attractors. Time series data obtained from these dynamical systems must be sampled properly in order to estimate the fractal dimensions of these strange attractors with the greatest possible accuracy. The Smale-Williams attractor is used here because the value of the correlation dimension for this attractor can be determined analytically. Two types of sampling strategies are considered to determine how a time series might be best used to estimate the characteristics of the attractor. This attractor can be characterized by either a histogram of distances from the origin to each point on the attractor or by an estimate of its correlation dimension. Differences between histograms of a sufficiently long control series and subsets of this series are used to quantify the accuracy of representations of the attractor. Differences between analytic and estimated values of the correlation dimension are also used. Finally, the independence of the time series data is quantified in a new way and the relationship between the independence of sampled data and the accuracy of characterizations of the attractor by histograms of sampled data or by estimates of the correlation dimension is examined. GRA

**N93-18907*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**FAULT DETECTION USING A TWO-MODEL TEST FOR CHANGES IN THE PARAMETERS OF AN AUTOREGRESSIVE TIME SERIES**
P. Scholtz and P. Smyth *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 83-100 (For primary document see N93-18897 06-32)
(RTOP 310-20-65-91)
Avail: CASI HC A03/MF A03

## 66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

**N93-17992#** Strategic Defense Initiative Organization, Washington, DC.
**REPORT TO CONGRESS ON THE STRATEGIC DEFENSE INITIATIVE, 1992**
Jul. 1992 125 p
(AD-A258449) Avail: CASI HC A06/MF A02

The Department of Defense is developing for deployment a ballistic missile defense system that will provide protection to the United States, its forward deployed forces, and allies and friends against limited ballistic missile strikes, whatever their source. The concept under which this system is being developed is called Global Protection Against Limited Strikes (GPALS). The passage of the Missile Defense Act (MDA) of 1991 moved the Administration and Congress close to a consensus on the role of ballistic missile defenses. The goal contained in the MDA is a reflection of the determination of Congress to defend the U.S. against limited ballistic missile attack and defend U.S. forward deployed forces and our friends and allies with highly effective ballistic missile defenses. GRA

**N93-18208#** Air War Coll., Maxwell AFB, AL.
**DEVELOPMENTAL STRATEGY FOR UNITED STATES SPACE POWER**
Roger B. Graves Apr. 1992 31 p
(AD-A258356) Avail: CASI HC A03/MF A01

The demise of the Soviet Union as the major adversary of the United States has created an unusual challenge for senior military leaders. The Soviet threat has been a major justification for the development of military space capabilities that represent a large share of defense spending. The Desert Storm experience was a watershed for space power as military leaders discovered how dependent combat forces had become on space support. With a pressing need for budget reductions because of the national deficit, the perceived decline of the Soviet threat, and the increased dependence on space power, our leaders must convince taxpayers and Congress that developing space power is vital to our national security interests. To ensure that no scarce resources are wasted, a careful space force development strategy must be built to support our space force employment strategy. Many factors influence that strategy, and the strategy maker must understand their effects. GRA

# 67 THEORETICAL MATHEMATICS

Includes topology and number theory.

**N93-17840#** Rome Univ. (Italy). Dipt. di Fisica.
**LIE-ADMISSIBLE PERTURBATION METHODS FOR OPEN QUANTUM SYSTEMS**
A. Jannussis (Patras Univ., Greece ), R. Mignani (Institute for Basic Research, Palm Harbor, FL.), and D. Skaltsas (Patras Univ., Greece ) 3 Dec. 1992 12 p
(Preprint-845; ETN-93-92947) Avail: CASI HC A03/MF A01

Open quantum systems described by a Hamiltonian of the type H(sub 0) + (lambda)V where lambda is a small parameter are considered. Perturbative methods of solution of the corresponding Liouville-Von Neumann and Schroedinger equations are developed, by introducing 'dissipation' operators which connect conservative to dissipative systems. In the case of the density matrix, the corresponding operator lambda is the non-unitary lambda transformation of Misra, Prigogine and Courbage. The perturbative approach possesses a Lie admissible structure, since the 'dissipation' operators obey time evolution equations whose brackets are the product of a Lie admissible algebra. Explicit solutions for such operators are found in the form of series expansions in lambda. The matrix formulation of the results is given. ESA

**N93-17939#** Rome Univ. (Italy). Dipt. di Fisica.
**LAGRANGIAN CHAOS: TRANSPORT, MIXING, AND DIFFUSION IN FLUIDS**
A. Crisanti, M. Falcioni, G. Paladin (Aquila Univ., Italy ), and A. Vulpiani 23 Nov. 1991 120 p Submitted for publication Sponsored in part by Ist. Nazionale di Fisica Nucleare
(Nota-Interna-988; ETN-93-93352) Avail: CASI HC A06/MF A02

The problem of Lagrangian chaos (of the chaotic motion of fluid particles) is reviewed using methods and tools borrowed from the theory of dynamical systems. The main subject is the behavior of fluid particles which move according to regular velocity fields, that is, in the absence of Eulerian chaos or turbulence. In this framework, particular attention is given to the relation with mixing, transport, and diffusion phenomena in fluids. A possible general mechanism for the onset of Lagrangian chaos in two dimensional fluids is discussed. Evidence that the presence of a chaotic velocity field (Eulerian chaos) is not relevant for many properties of the particle motion is provided. Similar methods are applied to the analysis of the properties of the small scale statistics of passive scalar and magnetic fields. The long time diffusion features of contaminant particles, which show the importance of the combined effect of the molecular diffusion and the geometrical structures of the velocity field, are also studied. ESA

**N93-18770*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**COUPLING BETWEEN PLATE VIBRATION AND ACOUSTIC RADIATION**
**Final Report**
Abdelkader Frendi (Analytical Services and Materials, Inc., Hampton, VA.), Lucio Maestrello (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), and Alvin Bayliss (Northwestern Univ., Chicago, IL.) Washington Dec. 1992 38 p Submitted for publication
(Contracts NAS1-18605; NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-189741; NAS 1.26:189741; ICASE-92-67) Avail: CASI HC A03/MF A01

A detailed numerical investigation of the coupling between the vibration of a flexible plate and the acoustic radiation is performed. The nonlinear Euler equations are used to describe the acoustic fluid while the nonlinear plate equation is used to describe the plate vibration. Linear, nonlinear, and quasi-periodic or chaotic vibrations and the resultant acoustic radiation are analyzed. We find that for the linear plate response, acoustic coupling is negligible. However, for the nonlinear and chaotic responses, acoustic coupling has a significant effect on the vibration level as the loading increases. The radiated pressure from a plate undergoing nonlinear or chaotic vibrations is found to propagate nonlinearly into the far-field. However, the nonlinearity due to wave propagation is much weaker than that due to the plate vibrations. As the acoustic wave propagates into the far-field, the relative difference in level between the fundamental and its harmonics and subharmonics decreases with distance. Author

**N93-19160*#** Observatoire du Mont-Gros, Nice (France).
**POLYNOMIAL APPROXIMATION OF POINCARE MAPS FOR HAMILTONIAN SYSTEM**
Claude Froeschle and Jean-Marc Petit *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 201-204 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

# 70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**N93-18634#** Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay (France). Programme 4: Robotique, Image et Vision.
**THREE-DIMENSIONAL MOTION COMPUTATION AND OBJECT SEGMENTATION IN A LONG SEQUENCE OF STEREO FRAMES [ESTIMATION DU MOUVEMENT 3D ET SEGMENTATION D'OBJETS DANS UNE SEQUENCE LONGUE DE TRIPLETS STEREOSCOPIQUES]**
Zhengyou Zhang and Olivier D. Faugeras Jul. 1991 49 p Sponsored in part by Commission of the European Communities
(INRIA-RR-1438; ETN-93-92645) Avail: CASI HC A03/MF A01

The problem of computing the three-dimensional (3D) motions of objects in a long sequence of stereo frames is addressed. The approach is bottom-up and consists of two levels. The first level deals with the tracking of 3D tokens from frame to frame and the estimation of their kinetics. The processing is completely parallel for each token. The second level groups tokens into objects based on their kinematic parameters, controls the processing at the low level to cope with problems such as occlusion, disappearance and appearance of tokens, and provides information to other components of the system. This approach is implemented using 3D line segments obtained from stereo as the tokens. Classical kinematics are used and closed form solutions are derived for some special, but useful, cases of motions. The motion computation problem is then formulated as a tracking problem in order to apply the extended Kalman filter. The tracking is performed in a prediction-matching-update loop in which multiple matches can be handled. Tokens are labeled by a number called its support of existence which measures their adequation to the measurements. If this number goes beyond a threshold, the token disappears. The individual line segments can be grouped into rigid objects according to the similarity of their kinematic parameters. Experiments using synthetic and real data were carried out, and the results were found to be quite good. ESA

**N93-19014#** Technical Univ. of Istanbul (Turkey).
**A DYNAMIC ANALYSIS OF PIEZOELECTRIC STRAINED ELEMENTS**
**Final Report**
M. C. Dokmeci Jun. 1992 283 p
(AD-A259011) Avail: CASI HC A13/MF A03

This report is addressed to the dynamic analysis of piezoelectric structural elements under a static mechanical bias. In the first part of the report, the current literature pertaining to the dynamic applications of piezoelectric crystals is reviewed; attention is confined to vibrations of structural elements. In the second part, the fundamental equations of piezoelectric media are expressed in variational form as the Euler-Lagrange equations of certain integral and differential types of variational principles. These variational principles are deduced from a general principle of physics by augmenting it through Friedrichs's transformation. In the third part, the system of approximate lower order governing equations of piezoelectric strained elements is systematically and consistently deduced in invariant form from the three-dimensional equations of piezoelectricity by means of the variational principles. The governing equations accommodate all the types of extensional, flexural, and torsional as well as coupled motions of piezoelectric one- and two-dimensional elements. Also, the uniqueness of solutions is examined and two unified numerical algorithms which are based on Kantorovich's method and the method of moments are described for solutions of the governing equations. GRA

# 71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

**N93-19001#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ENHANCEMENT OF AUDIO LOCALIZATION CUE SYNTHESIS BY ADDING ENVIRONMENTAL AND VISUAL CUES M.S. Thesis**
Eric L. Scarborough Dec. 1992 129 p
(AD-A259041; AFIT/GE/ENG/92D-34) Avail: CASI HC A07/MF A02

An audio localization cue synthesizer, the DIRectional Audio Display (DIRAD) was used to simulate auditory distance, room reflections, and to provide spatial audio for computer graphics images. The DIRAD processes input audio signals to generate spatially located sounds for headphone listening. The DIRAD can position audio sources around the head and these sounds are stable with respect to the listener's head position. An interactive, real-time simulation of auditory distance and room reflections was accomplished using the DIRAD in combination with a Silicon Graphics audio processor board installed in a Personal Iris 4D/35. Several demonstrations of auditory distance and the effects of early reflections are detailed, including a simulation of a direct sound source and three reflections that employed two DIRAD systems. Stored sound files were used to accompany three dimensional graphics images that were displayed on both a Silicon Graphics CRT and a three dimensional optical display device. The use of the 4D/35 audio processor board proved to be an effective means of preprocessing audio for the DIRAD for these simulations. The combination of AFIT's Silicon Graphics workstations and the DIRAD proved to be a practical solution to the problem of combining virtual visual and audio cues. GRA

**N93-19075#** Dayton Univ., OH. Research Inst.
**USER'S REFERENCE GUIDE FOR NOISE ASSESSMENT PREDICTION SYSTEM (NAPS) Final Report**
Joyce A. Smith, James K. Luers, and Mark A. Dietenberger Jul. 1992 66 p
(Contract DAAD07-89-C-0209)
(AD-A258865; ASL-CR-92-0209-1) Avail: CASI HC A04/MF A01

The noise assessment and prediction system (NAPS) model provides an estimate of the surface peak noise intensity in all directions surrounding a blast source. The model makes use of a personal computer. An essential feature of the model is its ability to account for meteorological and topographical variations in the calculation of blast sound propagation. In performing noise intensity estimates, acoustic ray traces are generated over a sufficient range of azimuth and elevation angles to define the focusing and shadow regions in the area surrounding the airblast. The acoustics of the model include the effects of spherical acoustic spreading, absorption, focusing, shadow zones, reflection of rays from water, interference of multiple rays arriving at the same location, and the directional asymmetry of a blastwave. The NAPS model has been implemented at Aberdeen Proving Ground, Maryland, using acoustic sounder, upper air, and surface station data to provide on-line meteorological input. Plots of ray trace trajectories and sound intensity contour levels on a background map of the Aberdeen area, along with tabular data, are included as model features. This user's reference guide describes the procedures for running the NAPS model. It also includes examples of the required input data files and examples of the graphic outputs generated by the model. GRA

**N93-19082#** Washington State Univ., Pullman. Dept. of Physics.
**RAY METHODS FOR ACOUSTIC SCATTERING, OPTICS OF BUBBLES, DIFFRACTION CATASTROPHES, AND NONLINEAR ACOUSTICS Final Technical Report, 1 Jan. 1985 - 30 Sep. 1991**
Philip L. Marston 24 Nov. 1992 ~49 p
(Contract N00014-85-C-0141)
(AD-A258938) Avail: CASI HC A03/MF A01

This report indexes research completed in several areas. The first area was ray methods for the scattering of sound by elastic objects in water. In this area, glory scattering was analyzed for solid and fluid spheres and calibration targets. Ray methods were extended to leaky Rayleigh and whispering gallery waves and then to leaky Lamb waves on shells. A related product expansion of the S function was studied. The second area was acoustical and optical diffraction catastrophes. These were observed and calculated for several situations of varying degree of complexity. The third area was light scattering by bubbles in water. In this area observations and physical optics approximations were made for backward and forward glories, critical angle scattering, optical levitation, and photoacoustic emission. The fourth area was nonlinear acoustics and radiation pressure. This area included studies of the interaction of sound with sound in bubble layers and free surfaces, radiation pressure and torques on drops, rapid cavitation due to shock reflection, and the response of hydrodynamic shear layers to oscillations. GRA

**N93-19111#** New Mexico State Univ., Las Cruces.
**SCATTERING OF ACOUSTICAL WAVES BY A SPINNING ATMOSPHERIC TURBULE Final Report**
George H. Goedecke Sep. 1992 36 p
(Contract DAAD07-86-C0034)
(AD-A258783; ASL-CR-92-0001-2) Avail: CASI HC A03/MF A01

Theory is developed for acoustical scattering by localized quasistatic turbulent structures (turbules) that contain both flow and density variations. The quasistatic density variation is shown to be proportional to v(sup 2), where v is the (presumably small) ratio of flow speed to asymptotic acoustical wavespeed. The flow contributes terms O(v(sup 2)) to the scattering cross sections, while the density variations contribute terms O(v(sup 4)). Differential and total cross sections are calculated for a Gaussian spinning turbule model of effective radius a, for size parameters ka from 0.25 to 2.0, where k = 2 pi/lambda, lambda = wavelength, using the first Born approximation which is estimated to be valid for ka 2 for v(sub max) is less than 0.1. The contributions of the density variation are about three orders of magnitude smaller than those of the flow. The latter are proportional to (ka(sup 6)) and ((sin(theta))(sup 2)) x ((cos(theta))(sup 2)) x ((sin(theta(sub alpha)))(sup 2)) x sin(phi - phi(sub alpha)), where (theta, phi) are the P(polar, azimuthal) scattering angles, and (theta(sub alpha), phi(sub alpha)) are the spin axis angles. The contributions of the density variations go like (ka(sup 4)) and have a somewhat Rayleigh-like dependence on theta. A digitized Green function approach and computer algorithm are also developed, for the O(v(sup 2)) flow contributions only. In principle, this method would allow treatment of turbules of arbitrary structure, shape, and size. GRA

**N93-19888*#** Cornell Univ., Ithaca, NY. Dept. of Mechanical and Aerospace Engineering.
**PROPFAN NOISE PROPAGATION Final Report, Sep. 1990 - Aug. 1992**
Albert R. George and Ben Wel-C. Sim 15 Feb. 1993 22 p
(Grant NAG1-1078)
(NASA-CR-192221; NAS 1.26:192221) Avail: CASI HC A03/MF A01

The unconventional supersonic tip speed of advanced propellers has led to uncertainties about Propfan's noise acceptability and compliance with Federal Aviation Noise Regulation (FAR 36). Overhead flight testing of the Propfan with an SR-7L blade during 1989's Propfan Test Assessment (PTA) Program have shown unexpectedly high far-field sound pressure levels. This study here attempts to provide insights into the acoustics of a single-rotating propeller (SRP) with supersonic tip speed. At the same time, the role of the atmosphere in shaping the far-field noise characteristics is investigated. Derived from text

**N93-19400*#** Puerto Rico Univ., Mayaguez. Dept. of Chemical Engineering.
**EVALUATION OF ULTRASONIC CAVITATION OF METALLIC AND NON-METALLIC SURFACES**
Narinder K. Mehta *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 261-317 (For primary document see N93-19390 06-99)
Avail: CASI HC A04/MF A06

# 72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

**N93-17824#** Rome Univ. (Italy). Dipt. di Fisica.
**LIE-ISOTROPIC ENERGY-DEPENDENCE OF THE NEUTRAL K(SUB S) LIFETIME**

F. Cardone, R. Mignani (Institute for Basic Research, Palm Harbor, FL.), and R. M. Santilli 16 Mar. 1992 9 p
(Preprint-874; ETN-93-92974) Avail: CASI HC A02/MF A01

The currently available phenomenological data on the behavior of the mean life of unstable hadrons with energy are studied. Fits to the experimental data in the neutral K(sub S) lifetime in the energy range 30 to 350 GeV show a good agreement with a generalized expression for time dilation, obtained by a Lie isotropic lifting of the Poincare symmetry. Results on the energy dependence of the parameters that, in the Lie isotropic theory, determine the deformed Minkowski metric inside hadrons, are given. ESA

**N93-17876#** Rome Univ. (Italy). Dipt. di Fisica.
**RELATIVISTIC TWO BODY EQUATIONS AND NUCLEAR INTERACTIONS**
M. DeSanctis (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) and D. Prosperi (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 10 Sep. 1991 7 p
(Nota-Interna-985; ETN-93-93349) Avail: CASI HC A02/MF A01

The adaptation of a relativistic two body wave equation for the study of nuclear systems is reported. A specific one boson exchange model was constructed. The introduction of the Delta resonance degrees of freedom in the formalism is discussed. ESA

**N93-17877#** Rome Univ. (Italy). Dipt. di Fisica.
**A TWO-BODY COVARIANT EQUATION FOR INTERACTING NUCLEONS**
M. DeSanctis (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) and D. Prosperi 23 Sep. 1991 10 p
(Nota-Interna-986; ETN-93-93350) Avail: CASI HC A02/MF A01

A covariant generalization of a recently introduced relativistic two body equation is proposed. The result for the case of two spin 1/2 particles is formally different from the one given by other authors. The theory is adapted to the study of interactions of isovector nature. The work may be considered as a starting point to study relativistic effects in three-body systems and in the electromagnetic interactions of the few body nuclear systems. ESA

**N93-17931#** Groningen Rijksuniv. (Netherlands). Kernfysisch Verneller Inst.
**[ACTIVITIES REPORT OF THE KERNFYSISCH VERSNELLER INSTITUTE] Annual Report, 1991**
H. W. Wilschut, ed. and R. Morgenstern, ed. Apr. 1992 185 p
(ETN-93-93340) Avail: CASI HC A09/MF A02

Results of research work in nuclear, atomic, and applied nuclear physics, performed at the KVI on the Netherlands during 1991 are presented. The results and updates of projects are presented under the following headings: experimental nuclear physics (structure and reaction dynamics), fundamental interactions, theory, atomic physics, the AGOR superconducting cyclotron project, environmental physics, nuclear medicine, technical support. Publications and scientific presentations are listed. ESA

**N93-17932#** Rome Univ. (Italy). Dipt. di Fisica.
**SOLID STATE AND THE STANDARD MODEL**
Luciano Pietronero and Giorgio Salvani 20 May 1991 13 p
(Nota-Interna-980; ETN-93-93344) Avail: CASI HC A03/MF A01

An attempt is made to look for links among the coupling constants and masses which are necessary for a proper formulation of the measurement process and that are left unspecified by the electroweak theory and quantum chromodynamics (that is the Standard Model). According to Landau and Lifshitz and further developments, the existence of classical objects (the detectors) are required for a satisfactory formulation of the measurement process. It is conjectured that these statements imply the existence of a 'solid state' of matter, in order to give operational meaning to the theory. In fact stable matter is necessary to establish a unit of length and to measure the coordinates of an event. From this perpective, the conditions of stability of the solid state with respect to quantum fluctuations are analyzed in order to define their implications in the fundamental constants and in the masses of particles. The result is that the requirement of a stable solid state implies the condition that the electron should be much lighter than the proton, regardless of the values of Planck contant and electron charge. This condition results from any attempt to give an experimental significance to the Standard Model. ESA

**N93-17933#** Rome Univ. (Italy). Dipt. di Fisica.
**PION DISCOVERY [LA SCOPERTA DEL PIONE]**
M. Grilli 21 Jun. 1991 54 p In ITALIAN
(Nota-Interna-983; ETN-93-93347) Avail: CASI HC A04/MF A01

Past work on mesons is discussed, and the conclusions of the work of Lattes, Occhialini, and Powell concerning mesons are reported. The physics of pions and particle acceleration are discussed. In particular, the artificial production of the pion, the neutral pion, and pion mass, are reported. First mass measurements of pions and muons are given. Early measurements of charged pion lifetime and average lifetime are given. Measurements of pion spin and parity and nuclear interactions of pions are discussed. ESA

**N93-17942#** Rome Univ. (Italy). Dipt. di Fisica.
**IDENTIFICATION OF HIGH Pt JET EVENTS PRODUCED BY A RESOLVED PHOTON AT HERA AND RECONSTRUCTION OF THE INITIAL STATE PARTON KINEMATICS**
Giulio DAgostini (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) and Daniela Monaldi (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 4 Feb. 1992 8 p Presented at Workshop on Physics at HERA, Hamburg, Germany, Oct. 1991 Submitted for publication
(Nota-Interna-991; ETN-93-93355) Avail: CASI HC A02/MF A01

A study of the possibility offered by the HERA (German acronym for hadron electron storage ring) detectors to identify the events where a parton of the proton interacts with a parton of the (quasi) real photon is presented. The presence of hadronic fragments in the direction of the photon outside of the beam is found to allow the identification of the two jet events produced by a resolved photon, with good efficiency and low background from the direct photon events. The possibility of reconstructing the fractional momenta of the two incoming partons is demonstrated. ESA

**N93-17943#** Rome Univ. (Italy). Dipt. di Fisica.
**QUARK/GLUON JET SEPARATION IN THE PHOTOPRODUCTION REGION WITH A NEURAL NETWORK ALGORITHM**
Giuseppe Barbagli (Florence Univ., Italy ), Giulio DAgostini (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), and Daniela Monaldi (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 4 Feb. 1992 9 p Presented at Workshop on Physics at HERA, Hamburg, Germany, Oct. 1991 Submitted for publication
(Nota-Interna-992; ETN-93-93356) Avail: CASI HC A02/MF A01

A neural network approach used to separate quark and gluon jets at HERA (German acronym for hadron electron, storage ring) in the photoproduction region is described. The network was trained to learn the structural features of the jets. The jet recognition was used to enhance the contents of a sample of photon gluon fusion events by reducing the background of quantum chromodynamic Compton events. ESA

**N93-17944#** Rome Univ. (Italy). Dipt. di Fisica.
**A RELATIVISTIC COUPLED-CHANNEL WAVE-EQUATION WITH N AND DELTA DEGREES OF FREEDOM**
M. DeSanctis (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) and D. Prosperi 16 Mar. 1992 13 p
(Nota-Interna-993; ETN-93-93357) Avail: CASI HC A03/MF A01

A previously introduced two body relativistic wave equation is generalized to include the Delta degrees of freedom. The negative energy states are consistently considered. Spurious spin-1/2 fields for the Delta isobar are discarded by means of a suitable projection procedure. A specific pi- and rho-exchange model is constructed and a non-relativistic reduction, up to order c(exp -2), is given for the pi-exchange case. ESA

**N93-17955#** Rome Univ. (Italy). Dipt. di Fisica.
**A RELATIVISTIC STUDY OF NUCLEAR INTERACTIONS**
M. DeSanctis and D. Prosperi (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 23 May 1991 17 p
(Nota-Interna-981; ETN-93-93345) Avail: CASI HC A03/MF A01

A new relativistic wave equation is applied to the study of nuclear forces by constructing a specific 'one boson exchange model'. A preliminary non relativistic reduction is performed in order to fit the soft core Reid potential. The meson parameters determined by this fitting procedure favorably compare with those given by other theoretical models. ESA

**N93-18140*#** Colorado State Univ., Fort Collins. Dept. of Mechanical Engineering.
**DISCRIMINATION OF IONIC SPECIES FROM BROAD-BEAM ION SOURCES**
J. R. Anderson Washington Jan. 1993 123 p
(Grant NGT-50370)
(NASA-CR-4483; M-708; NAS 1.26:4483) Avail: CASI HC A06/MF A02

The performance of a broad-beam, three-grid, ion extraction system incorporating radio frequency (RF) mass discrimination was investigated experimentally. This testing demonstrated that the system, based on a modified single-stage Bennett mass spectrometer, can discriminate between ionic species having about a 2-to-1 mass ratio while producing a broad-beam of ions with low kinetic energy (less than 15 eV). Testing was conducted using either argon and krypton ions or atomic and diatomic oxygen ions. A simple one-dimensional model, which ignores magnetic field and space-charge effects, was developed to predict the species separation capabilities as well as the kinetic energies of the extracted ions. The experimental results correlated well with the model predictions. This RF mass discrimination system can be used in applications where both atomic and diatomic ions are produced, but a beam of only one of the species is desired. An example of such an application is a 5 eV atomic oxygen source. This source would produce a beam of atomic oxygen with 5 eV kinetic energy, which would be directed onto a material specimen, to simulate the interaction between the surface of a satellite and the rarefied atmosphere encountered in low-Earth orbit. Author

**N93-18220#** Surrey Univ., Guildford (England).
**INTERNATIONAL SYMPOSIUM ON MACROCYCLIC LIGANDS FOR THE DESIGN OF Ne MATERIALS: PROGRAMME AND ABSTRACTS**
16 Sep. 1992 198 p Symposium held in Guildford, UK, 14-16 Sep. 1992
(Contract DAJA-45-92-M-0157)
(AD-A258402; R/D-6586-CH-02) Avail: CASI HC A09/MF A03

The topics covered include the following: Synthetic Aspects: Design of Anion Receptors - Applications; Redox-Responsive Ammonium Cation Receptors; Asymmetric Synthesis of Chiral Macrocyclic Ligands; Natural Lypophilic Sequestering Agents; Complexation Properties of Macrocycles Containing Main Group Elements; Tetra-Azamacrocycles Derived from N-Substituted Aromatic Heterocycles: Synthesis and Some Properties; Crown-Ether Phthalocyanines as Alkali-Metal Reagents; Synthesis of a Cu(II) Complex of Macrocyclic Octaamine and its Spectral and Electrochemical Characterisation; New Redox-Active Tetrathiafulvalene and Ferrocene Macrocyclic Receptor Molecules; Fluorescent Calix (4) Arene Sodium Sensor; Synthesis and Extraction Properties of a New EDTA Derivative; and Calculation of Ion Binding Equilibria with Macrocycle Ligands Using Molecular Dynamics Computer Simulation. GRA

**N93-18324#** Rome Univ. (Italy). Dipt. di Fisica.
**HEAVY QUARKS IN LATTICE QCD**
Luciano Maiani (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 14 Feb. 1991 22 p Presented at Present and Future of Collider Physics, Rome, Italy, 20-22 Sep. 1990 Submitted for publication Sponsored by Ministero della Pubblica Istruzione
(Preprint-786; ETN-93-92896) Avail: CASI HC A03/MF A01

Lattice calculations of the weak coupling of D and B mesons are reviewed. Investigations with lattice Quantum Chromodynamics (QCD) techniques, on the properties of mesons made by the heaviest quarks, charmed and beauty mesons, are summarized. The interaction of quarks and gluons in QCD is described. The equations show that the charm mass is not asymptotic for weak lifetimes. Several form factors at zero momentum transfer are given. The f sub B in the static limit is considered. Lattice QCD calculation gave interesting results, but a clear sign that the deep nonperturbative aspects of the strong interactions can be reproduced in this way is lacking. The quark model is less reliable, it is not protected by the nonrenormalization theorems, so useful for light quark systems, and lattice calculations to 20 to 30 percent accuracy are adequate. ESA

**N93-18388#** Westinghouse Hanford Co., Richland, WA.
**MOCAL: A MONTE CARLO ALBEDO CODE**
R. J. Morford, L. L. Carter, and E. R. Siciliano Jan. 1992 9 p Presented at the Meeting on New Horizons in Radiation Protection and Shielding, Pasco, WA, 26 Apr. - 1 May 1992
(Contract DE-AC06-87RL-10930)
(DE93-002049; WHC-SA-1430; CONF-920431-29) Avail: CASI HC A02/MF A01

The MOCAL code is a Monte Carlo code that uses pre-existing albedo data files to determine neutron penetrations into shielding air gaps. By using the albedos along the bounding surfaces of the gaps, expensive computational tracking of neutrons through material regions is eliminated. Thus, the run-time for MOCAL is relatively short, compared to conventional Monte Carlo methods of tracking neutrons completely through the materials. Also as a result of this albedo treatment, MOCAL is very easy to use, with the time required to prepare a typical input data file to be less than 15 minutes in most cases. DOE

**N93-18392#** Georgia Inst. of Tech., Atlanta. School of Physics.
**NUCLEAR STRUCTURE FROM RADIOACTIVE DECAY**
J. L. Wood 30 Sep. 1992 25 p
(Contract DE-FG05-87ER-40330)
(DE93-002795; DOE/ER-40330/64) Avail: CASI HC A03/MF A01

The most important aspect of the wind-up of UNISOR-based research is completion of student theses. Analysis is proceeding on extensive studies in the neutron-deficient rare earth isotopes with N less than 82 and the neutron-deficient region below Z = 82. These studies address the onset of deformation in the N less than 82, Z greater than 50 open shell region and shape coexistence in the N is approximately 104, Z less than 82 region, respectively. The main ongoing topics are shape coexistence in nuclei and the microscopic structure of collective motion in nuclei from a phenomenological point of view. New topics this year focus on the structure of nuclei near the N = Z line. Two topics have been chosen for detailed study: shape coexistence and electric monopole transition strengths. DOE

**N93-18398#** Arizona Univ., Tucson. Dept. of Chemistry.
**CHEMICAL ACTIVATION OF MOLECULES BY METALS: EXPERIMENTAL STUDIES OF ELECTRON DISTRIBUTIONS AND BONDING**
D. L. Lichtenberger 1992 7 p
(Contract DE-FG02-86ER-13501)
(DE93-002366; DOE/ER-13501/T2) Avail: CASI HC A02/MF A01

The purpose of this research program is to obtain experimental information on the different fundamental ways in which metals bond and activate organic molecules. Our approach has been to directly probe the electronic interactions between metals and molecules through a wide variety of ionization spectroscopies and other techniques and to investigate the relationships with bonding modes, structures, and chemical behavior. During this period, we have done the following: (1) characterized the electronic features of diphosphines and monophosphines in their coordination to metals; (2) carried out theoretical and experimental investigations of the bonding capabilities of C60 to transition metals; (3) developed techniques for the imaging of single molecules on gold substrates that emphasizes the electronic backbonding from the metal to the molecule; (4) obtained the high resolution photoelectron spectrum of pure C70 in the gas phase; (5) compared the bonding of eta(sup 1)-acetylide ligands to the bonding of other small organic molecules with metals; and (6) reported the photoelectron spectra and bonding of (eta)(sup 3)-cyclopropenyl groups to metals. DOE

**N93-18402#** Maryland Univ., College Park. Dept. of Chemistry.
**NUCLEAR STRUCTURE STUDIES**
W. B. Walters 31 Aug. 1992 18 p
(Contract DE-FG05-88ER-40418)
(DE93-002791; DOE/ER-40418/5) Avail: CASI HC A03/MF A01

New results are reported for the decay and nuclear orientation of I-114, I-116 and Sb-114 as well as data for the structure of daughter nuclides Te-114 and Te-116. New results for IBM-2 calculations for the structure of Xe-126 are also reported. A new approach to the problem of the underproduction of A = 120 nuclides in the astrophysical r-process is reported. DOE

**N93-18413#** Lowell Univ., MA. Radiation Lab.
**NEUTRONS SCATTERING STUDIES IN THE ACTINIDE REGION**
G. H. R. Kegel and J. J. Egan Sep. 1992 21 p
(Contract DE-FG02-86ER-40246)
(DE93-003655; DOE/ER-40246/7) Avail: CASI HC A03/MF A01

During the last report period, we investigated the following areas: prompt

fission neutron energy spectra measurements; neutron elastic and inelastic scattering from Pu-239; neutron scattering in Ta-181 and Au-197; response of a U-235 fission chamber near reaction thresholds; two-parameter data acquisition system; 'black' neutron detector; investigation of neutron-induced defects in silicon dioxide; and multiple scattering corrections. Four Ph.D. dissertations and one M.S. thesis were completed during the report period. Publications consisted of three journal articles, four conference papers in proceedings, and eleven abstracts of presentations at scientific meetings. There are currently four Ph.D. and one M.S. candidates working on dissertations directly associated with the project. In addition, three other Ph.D. candidates are working on dissertations involving other aspects of neutron physics in this laboratory. DOE

**N93-18449#** California Univ., Berkeley. Lawrence Berkeley Lab. Dept. of Physics.

**MEDIUM ENERGY MESON RESEARCH**

K. M. Crowe 1992 62 p

(Contract DE-FG03-87ER-40323)

(DE93-004133; DOE/ER-40323/T6) Avail: CASI HC A04/MF A01

The activities of this group are primarily concerned with experiments using the Crystal Barrel Detector. This detector is installed and operating at the Low Energy Antiproton Ring (LEAR) at CERN. QCD, the modern theory of the strong interaction, is reasonably well understood at high energies, but unfortunately, low-energy QCD is still not well understood, and is far from being adequately tested. The Crystal Barrel experiments are designed to provide some of the tests. The basic line of research involves meson spectroscopy, analyses bearing on the quark and/or gluon content of nuclear states, and the exploration of mechanisms and rules which govern p(-p) annihilation dynamics. The Crystal Barrel Detector detects and identifies charged and neutral particles with a geometric acceptance close to 100 percent. The principal component of the detector is an array of 1,380 CsI(T1) crystals. These crystals surround a Jet Drift Chamber (JDC), located in a 1.5 Tesla magnetic field, which measures the momentum and dE/dx of charged particles. One of the very interesting physics goals of the detector is a search for exotic mesonic states -- glueballs and hybrids. Annihilation at rest will be studied with both liquid and gaseous hydrogen targets. The gaseous target offers the possibility of triggering on atomic L-shell X rays so that specific initial angular momentum states can be studied. These topics as well as other related topics are discussed in this report. DOE

**N93-18509#** Brookhaven National Lab., Upton, NY.

**WORKSHOP ON HADRON STRUCTURE FROM PHOTO-REACTIONS AT INTERMEDIATE ENERGIES**

A. M. Nathan, ed. and A. M. Sandorfi, ed. 1992 148 p Workshop held in Brookhaven, NY, 28-29 May 1992

(Contract DE-AC02-76CH-00016)

(DE93-001904; BNL-47972; CONF-9205234) Avail: CASI HC A07/MF A02

This report contains papers on the following topics: The proton Compton effect; recent measurements of the electric and magnetic polorizabilities of the proton; experiments on the electric polarizability of the neutron; chiral symmetry and nucleon polarizabilities; chiral model predictions for electromagnetic polarizabilities of the nucleon, a consumer report; the polarizabilities of bound nucleons; nucleon polarizability in free space and in nuclear matter; mechanisms of photon scattering on nucleons at intermediate energies; pion polarizabilities in chiral perturbation theory; pion polarizabilities and the shielding of sigma(700)-meson exchange in gamma(gamma) yields pi(pi) processes; pion and kaon polarizabilities in the quark confinement model; radiative pion photoproduction and pion polarizabilities; pion and sigma polarizabilities and radiative transitions; the quadrupole amplitude in the gamma(nu)-delta transition; pion photoproduction and the gamma(nu)-delta amplitudes; effective-Lagrangians, Watson's theorem, and the E2/M1 mixing ratio in the excitation of the delta resonance; new measurements of the p((rvec gamma), pi(sup o)) reaction; multipole analyses and photo-decay couplings at intermediate energies; Compton scattering off the proton; connections between Compton scattering and pion photoproduction in the delta region; single-pion electroproduction and the transverse one-half and scalar helicity transition form factors; relativistic effects, QCD mixing angles, and nu yields nu(gamma) and delta yields gamma(nu) transition form factors; and electroproduction studies of the nu yields delta transition at Bates and CEBAF. DOE

**N93-18522#** Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Physics.

**NEUTRINO MASSES AND SOLAR NEUTRINOS**

L. Wolfenstein 1992 5 p

(Contract DE-FG02-91ER-40682)

(DE93-002416; DOE/ER-40682/3; CMU-HEP-92-08) Avail: CASI HC A01/MF A01

It has been pointed out by Bahcall and Bethe and others that all solar neutrino data can be explained by MSW oscillations with m(nu(sub mu)) is approximately 10(exp -3) eV consistent with ideas of grand unified theories (GUT's). There is a second possibility consistent with GUT's ideas with m(nu(sub tau)) is approximately 10(exp -2) eV and m(nu(sub mu)) is approximately 10(exp -4) eV. The two cases can be distinguished by a measurement of the solar neutrinos from Be(7). DOE

**N93-18538#** Drexel Univ., Philadelphia, PA. Dept. of Physics.

**EXPERIMENTAL PARTICLE PHYSICS**

R. I. Steinberg and C. E. Lane Sep. 1992 53 p

(Contract DE-FG02-91ER-40615)

(DE93-003884; DOE/ER-40615/2) Avail: CASI HC A04/MF A01

The goals of this research are the experimental testing of fundamental theories of physics beyond the standard model and the exploration of cosmic phenomena through the techniques of particle physics. We are working on the MACRO experiment, which employs a large-area underground detector to search for grand unification magnetic monopoles and dark matter candidates and to study cosmic ray muons as well as low- and high-energy neutrinos; the Chooz experiment to search for reactor neutrino oscillations at a distance of 1 km from the source; a new proposal (the Perry experiment) to construct a one-kiloton liquid scintillator in the Fairport, Ohio underground facility IMB to study neutrino oscillations with a 13 km baseline; and development of technology for improved liquid scintillators and for very-low-background materials in support of the MACRO and Perry experiments and for new solar neutrino experiments. DOE

**N93-18567*#** Christopher Newport Coll., Newport News, VA. Dept. of Biology, Chemistry, and Environmental Science.

**SHIELDING FROM SPACE RADIATIONS Progress Report, 1 Jun. - 1 Dec. 1991**

C. Ken Chang and Forooz F. Badavi 1 Dec. 1991 8 p

(Grant NAG1-1286)

(NASA-CR-191966; NAS 1.26:191966) Avail: CASI HC A02/MF A01

Progress during the period of 1 Jun. - 1 Dec. 1991 is presented. An analytical solution to heavy ion transport equation in terms of Green's function formalism is developed. The mathematical development is recasted into efficient computer code for space applications. The efficiency of this algorithm is accomplished by a nonperturbative technique of extending the Green's function over the solution domain. The code is also applied to accelerator boundary conditions to allow code validation in laboratory experiments. Author

**N93-18590#** Virginia Univ., Charlottesville. Dept. of Physics.

**EXPERIMENTS ON THE NUCLEAR INTERACTIONS OF PIONS AND ELECTRONS**

R. C. Minehart and K. O. H. Ziock Aug. 1992 31 p

(Contract DE-FG05-88ER-40390)

(DE93-001800; DOE/ER-40390/5) Avail: CASI HC A03/MF A01

The analysis of the deuterium content in the CD target used in an experiment to study the pi + d yields 2p reaction at incident pion energies from 4 to 20 MeV was completed. The final paper describing this experiment will be submitted for publication this summer. Analysis of LAMPF Exp. on pion absorption in He-4 is continuing. In 1991, we collaborated with D. Pocanic from the Univ. of Virginia on a measurement at LAMPF of the pi(0) production in pi(+) p interactions. This run proved the validity of the method and additional data were obtained in a second run during the summer of 1992, using a new target. Current collaborations at LAMPF include the search for the decay mu(+) yields e(+) + gamma(MEGA) and a measurement of the Michel rho parameter in the decay mu yields e + nu + nu. A U.Va.--PSI collaboration is measuring pion beta decay to an accuracy of less than 1 percent, using a large acceptance CsI detector to measure the pi(0) following decay of stopped pi(+) mesons. Most of the U.Va. effort is devoted to the CEBAF Large Acceptance Spectrometer (CLAS) program to the construction of the CLAS forward calorimeter. An apparatus to measure the properties of the scintillators with light from a

N2 laser was built in the spring of 1992. The electronic circuitry for the energy signal from the EGN detector and the circuitry needed to route the signals from all the photomultipliers to the TDC and ADC circuits are being developed. Experimental proposals for the study of electroproduction of nucleon resonances at CEBAF, including measurements with polarized beam and targets, are being developed. DOE

**N93-18621#** Brookhaven National Lab., Upton, NY.
**SYNCHROTRON RADIATION INDUCED X RAY MICRO ANALYSIS: A REALISTIC ALTERNATIVE FOR ELECTRON AND ION BEAM MICROSCOPY?**
K. Janssens, F. Adams (Universitaire Instelling Antwerpen, Wilrijk, Belgium), M. L. Rivers, and K. W. Jones 1992 49 p Presented at the 27th Annual Meeting of the Microbeam Analysis Society and the 19th Annual Meeting of the Microscopical Society of Canada, Boston, MA, Aug. 1992 Submitted for publication
(Contract DE-AC02-76CH-00016)
(DE93-001975; BNL-48003; CONF-9208150-1) Avail: CASI HC A03/MF A01

Synchrotron Radiation induced X-ray micro-Fluorescence analysis ((mu)-SRXRF) is compared with more conventional microanalytical techniques such as Secondary Ion Microscopy (SIMS) and Electron Probe X-ray Microanalysis (EPXMA) for two typical microanalytical applications. SRXRF and EPXMA are employed for the analysis of individual particles, showing the complementary character of the techniques. By means of element mapping of trace constituents in a heterogeneous feldspar, the strong and weak points of SRXRF in comparison to EPXMA and SIMS are illustrated. The most striking difference between SRXRF and the other two microanalytical methods is the ability of SRXRF to probe deep into the investigated material, whereas SIMS and EPXMA only investigate the upper surface of the material. The possibilities of SRXRF at third generation synchrotron rings is also briefly discussed. DOE

**N93-18763*#** Sverdrup Technology, Inc., Bay Saint Louis, MS.
**EMISSION SPECTRA OF SELECTED SSME ELEMENTS AND MATERIALS Report, FY 1991 - FY 1992**
Gopal D. Tejwani, David B. VanDyke, Felix E. Bircher, Donald G. Gardner, and Donald J. Chenevert Dec. 1992 133 p
(Contract NAS13-290)
(NASA-RP-1286; NAS 1.61:1286) Avail: CASI HC A07/MF A02

Stennis Space Center (SSC) is pursuing the advancement of experimental techniques and theoretical developments in the field of plume spectroscopy for application to rocket development testing programs and engine health monitoring. Exhaust plume spectral data for the Space Shuttle Main Engine (SSME) are routinely acquired. The usefulness of this data depends upon qualitative and quantitative interpretation of spectral features and their correlation with the engine performance. A knowledge of the emission spectral characteristics of effluent materials in the exhaust plume is essential. A study of SSME critical components and their materials identified 30 elements and 53 materials whose engine exhaust plume spectral might be required. The most important were evaluated using SSC's Diagnostic Testbed Facility Thruster (DTFT), a 1200-lbf, liquid oxygen/gaseous hydrogen rocket engine which very nearly replicates the temperature and pressure conditions of the SSME exhaust plume in the first Mach diamond. This report presents the spectral data for the 10 most important elements and 27 most important materials which are strongly to moderately emitting in the DTFT exhaust plume. The covered spectral range is 300 to 426 nm and the spectral resolution is 0.25 nm. Spectral line identification information is provided and line interference effects are considered. Author

**N93-19026*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**METHOD AND APPARATUS FOR PRODUCING A THERMAL ATOMIC OXYGEN BEAM Patent Application**
B. A. Banks, inventor (to NASA) and S. K. Rutledge, inventor (to NASA) 25 Jan. 1993 11 p
(NASA-Case-LEW-15614-1; NAS 1.71:LEW-15614-1;
US-Patent-Appl-SN-008026) Avail: CASI HC A03/MF A01

Atomic oxygen atoms are routed to a material through a sufficiently tortuous path so that vacuum ultraviolet radiation is obstructed from arriving at the surface of the material. However, the material surface continues to be exposed to the atomic oxygen. NASA

**N93-19092#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**COLLISIONAL DETACHMENT OF ANIONS USING FOURIER TRANSFORM MASS SPECTROMETRY M.S. Thesis**
Kevin B. Riehl Dec. 1992 163 p
(AD-A258972; AFIT/DS/ENP/92-3) Avail: CASI HC A08/MF A02

Fourier Transform Mass Spectrometry (FTMS) is used to make energy resolved ion-neutral reaction measurements at high translational energies (up to several hundred eV). The technique is demonstrated for collisional detachment of anions, and should be easily applied to other inelastic reactions. Collisional detachment cross sections of iodine anions onto gas phase targets of neon, xenon, and trifluoromethyl iodide are measured for 1-300 eV (lab frame). Peak detachment cross sections are roughly 2, 8.5, and 7 square angstroms, respectively. Ion kinetic measurements show the iodine anion is unreactive in trifluoromethyl iodide at thermal energies. Positive ion chemistry is consistent with previous results from well established techniques. However, the influence of internal energy is quantified for the first time by varying the electron energy of ion formation. Changes in the observed reactions of iodine cations and trifluoromethyl iodide cations are attributed to ion formation in excited states. Ionization and attachment cross sections for electron impact on trifluoromethyl iodide are reported for the first time over the energy range 10-50 eV. The ion motion in the FTMS ion trap is modelled and the relationship between the ion trajectory and the ion image current is quantified. GRA

**N93-19477#** Oak Ridge National Lab., TN.
**CLASSICAL AND QUANTUM DYNAMICS OF THE IMPULSIVELY DRIVEN HYDROGEN ATOM**
M. Melles (Tennessee Univ., Knoxville.), C. O. Reinhold (Tennessee Univ., Knoxville.), and J. Burgdoerfer (Tennessee Univ., Knoxville.) 1992 13 p Presented at the 12th International Conference on the Application of Accelerators in Research and Industry, Denton, TX, 2-5 Nov. 1992
(Contract DE-AC05-84OR-21400)
(DE93-002430; CONF-921116-3) Avail: CASI HC A03/MF A01

We investigate the classical and quantum dynamics of the hydrogen atom in a Rydberg state subject to a sequence of periodic and random pulses. One goal of this study is to test the validity of classical electron transport theories. We analyze the critical momentum transfer for which 10 percent of the Rydberg atoms are ionized after a large number of pulses as a function of the frequency of the perturbation. The quantum mechanical results for a periodic sequence of pulses exhibit clear structures which are not present in a classical simulation. These structures are shown to vanish for the case of stochastic pulses for which agreement is obtained between the classical and quantum mechanical results. The dynamics of the quantum mechanical periodic system is analyzed in terms of quasi-eigenstates of the period-one time evolution operator. DOE

**N93-19499#** Argonne National Lab., IL.
**NANOSTRUCTURED MATERIALS**
R. W. Siegel Sep. 1992 18 p Presented at the 1st Mexico-USA Symposium on the Frontiers in Materials Science, Ixtapa, Mexico, 24-27 Sep. 1991
(Contract W-31-109-eng-38)
(DE93-002990; ANL/CP-72336; CONF-9109446-1) Avail: CASI HC A03/MF A01

The recently developed ability to synthesize materials from atomic precursors under controlled conditions on a nanometer size scale (below 100 nm) has the potential for revolutionizing materials science and engineering. Such nanostructured materials can now be synthesized with modulation dimensionalities from zero (clusters) to three (nanophase materials), each with their own particular advantages. These advantages stem from such diverse effects as for example quantum confinement elastic strain accommodation, and grain size limitations. The general principles of nanostructured materials are considered and the particular opportunities for producing bulk nanophase materials with engineered properties, via the synthesis of metal and ceramic atom clusters followed by their in-situ assembly under controlled conditions, are presented as an example. DOE

**N93-19501#** Louisiana State Univ., Baton Rouge.
**A FUNDAMENTAL STUDY OF CONTRIBUTION TRANSPORT THEORY AND CHANNEL THEORY APPLICATIONS Progress Report**

M. L. Williams 1992 6 p
(Contract DE-FG02-89ER-12899)
(DE93-004315; DOE/ER-12899/3) Avail: CASI HC A02/MF A01

The objective of this three-year study is to develop a technique called 'channel theory' that can be used in interpreting particle transport analysis such as frequently required in radiation shielding design and assessment. Channel theory is a technique used to provide insight into the mechanisms by which particles emitted from a source are transported through a complex system and register a response on some detector. It is based on the behavior of a pseudo particle called a 'contributon', which is the response carrier through space and energy channels that connect the source and detector. 'Contributons' are those particles among all the ones contained in the system which will eventually contribute some amount of response to the detector. The specific goals of this projects are to provide a more fundamental theoretical understanding of the method, and to develop computer programs to apply the techniques to practical problems encountered in radiation transport analysis. The overall project can be divided into three components to meet these objectives: (1) Theoretical Development; (2) Code Development; and (3) Sample Applications. During the present third year of this study, an application of contributon theory to the analysis of radiation heating in a nuclear rocket has been completed, and a paper on the assessment of radiation damage response of an LWR pressure vessel and analysis of radiation propagation through space and energy channels in air at the Hiroshima weapon burst was accepted for publication. A major effort was devoted to developing a new 'Contributon Monte Carlo' method, which can improve the efficiency of Monte Carlo calculations of radiation transport by tracking only contributons. The theoretical basis for Contributon Monte Carlo has been completed, and the implementation and testing of the technique is presently being performed. DOE

**N93-19502#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Physics.
**PARTIAL-WAVE ANALYSES OF HADRON SCATTERING BELOW 2 GeV**
R. A. Arndt and L. D. Roper 1992 6 p
(Contract DE-FG05-88ER-40454)
(DE93-004368; DOE/ER-40454/T2) Avail: CASI HC A02/MF A01

The Center for Analysis of Particle Scattering (CAPS) in the Department of Physics at Virginia Polytechnic Institute and State University has analyzed basic two-body hadron reactions below 2 GeV for the last two decades. Reactions studied were nucleon-nucleon, pion - nucleon, K+ - nucleon and pion photoproduction systems. In addition to analyses of these reactions, a computer graphics system (SAID) has been developed and disseminated to over 250 research institutions using VAX computers. The computer-interactive system for disseminating information on basic scattering reactions is also accessible to the physics community through TELNET on the VPI&SU physics department VAX. DOE

**N93-19503#** Indiana Univ., Bloomington.
**THEORETICAL STUDIES IN MEDIUM-ENERGY NUCLEAR AND HADRONIC PHYSICS**
C. J. Horowitz, M. H. Macfarlane, T. Matsui, and B. D. Serot 1993 85 p
(Contract DE-FG02-87ER-40365)
(DE93-004373; DOE/ER-40365/6) Avail: CASI HC A05/MF A01

A proposal for theoretical nuclear physics research is made for the period April 1, 1993 through March 31, 1996. Research is proposed in the following areas: relativistic many-body theory of nuclei and nuclear matter, quasifree electroweak scattering and strange quarks in nuclei, dynamical effects in (e,e'p) scattering at large momentum transfer, investigating the nucleon's parton sea with polarized leptoproduction, physics of ultrarelativistic nucleus-nucleus collisions, QCD sum rules and hadronic properties, non-relativistic models of nuclear reactions, and spin and color correlations in a quark-exchange model of nuclear matter. Highlights of recent research, vitae of principal investigators, and lists of publications and invited talks are also given. Recent research dealt primarily with medium-energy nuclear physics, relativistic theories of nuclei and the nuclear response, the nuclear equation of state under extreme conditions, the dynamics of the quark-gluon plasma in relativistic heavy-ion collisions, and theories of the nucleon-nucleon force. DOE

**N93-19504#** Texas Univ., Austin. Dept. of Physics.
**INVESTIGATION OF PION-NUCLEUS INTERACTIONS**
C. F. Moore Sep. 1992 31 p
(Contract DE-FG05-87ER-40343)
(DE93-004375; DOE/ER-40343/6) Avail: CASI HC A03/MF A01

This report summarizes the work carried out by personnel from the University of Texas at Austin at the Los Alamos Clinton P. Anderson Meson Physics Facility (LAMPF). The research activities involved experiments done with the Energetic Pion Channel and Spectrometer (EPICS), the Low Energy Pion Channel (LEP), the Pion and Particle Physics Channel (P(sup 3)), the High Resolution Spectrometer (HRS), and planning a new experimental program associated with the new high-resolution Neutral Meson Spectrometer (NMS) at LAMPF. A brief overview of work supported by this grant is given followed by an account of the study of the double giant resonances in pion double charge exchange on V-51, In-115, and Au-197. This report contains a list of published papers and preprints, abstracts, and invited talks. These papers summarize experiments involving participants supported by this grant and indicate the work accomplished by these participants in this program of medium energy nuclear physics research. Lists of the most recent proposals on which we have participation at LAMPF, proposals which have been approved this past year to run as experiments, personnel who have participated in this research program are included. The research cited in this report is, in many cases, the collaborative effort of many groups associated with research at LAMPF. DOE

**N93-19507#** Rensselaer Polytechnic Inst., Troy, NY. Dept. of Physics.
**THEORETICAL ASPECTS OF ELECTROWEAK AND OTHER INTERACTIONS IN MEDIUM ENERGY PHYSICS**
N. C. Mukhopadhyay 1992 16 p
(Contract DE-FG02-88ER-40448)
(DE93-003714; DOE/ER-40448/5) Avail: CASI HC A03/MF A01

Progress in the study of electroweak structure of baryon resonances and in the analysis of data for pion and eta photoproduction is discussed. The following topics are addressed: (1) relations between pion photoproduction and Compton scattering in the Delta (1232) region; (2) paramagnetic polarizability of the proton; (3) the Bloom-Gilman duality and the disappearing Delta resonance; (4) dynamic symmetry in meson physics; (5) baryon spectroscopy; (6) electromagnetic excitation of the S(sub 11) (1535) resonance in the eta photo- and electroproduction; and (7) the Skyrme model approach to the baryon structure. DOE

**N93-19508#** Colorado Univ., Denver.
**FAST ALGORITHMS FOR TRANSPORT MODELS**
T. A. Manteuffel 1 Dec. 1992 13 p
(Contract DE-FG02-90ER-25086)
(DE93-003881; DOE/ER-25086/T1) Avail: CASI HC A03/MF A01

Numerical solution techniques for deterministic models of the transport of neutral and charged particles is developed and their effectiveness in both a production environment and on advanced architecture computers is demonstrated. The primary focus is on various versions of the linear Boltzman equation. These equations are fundamental in many important applications. This project is an attempt to integrate the development of numerical algorithms with the process of developing production software. A major thrust of this project will be the implementation of these algorithms on advanced architecture machines that reside at the Advanced Computing Laboratory (ACL) at Los Alamos National Laboratories (LANL). DOE

**N93-19516#** Brookhaven National Lab., Upton, NY.
**STRANGENESS SIGNALS IN HEAVY ION COLLISIONS**
L. P. Remsberg 1992 6 p Presented at the ICHEP-26: 26th International Union of Pure and Applied Physics (IUPAP) Conference on High Energy Physics, Dallas, TX, 6-12 Aug. 1992
(Contract DE-AC02-76CH-00016)
(DE93-002935; BNL-48118; CONF-920837-19) Avail: CASI HC A02/MF A01

The experimental data on strange meson and strange baryon production in relativistic heavy ion collisions are reviewed. DOE

**N93-19616#** Los Alamos National Lab., NM.
**EXPERIMENTAL EVALUATION OF SOFTWARE-DRIVEN DIGITAL GAIN-DRIFT COMPENSATION IN SCINTILLATOR GAMMA RAY SPECTROSCOPY**

P. A. Russo, P. A. Wenz, and J. A. Painter Sep. 1992 21 p
(Contract W-7405-eng-36)
(DE93-002623; LA-12390-MS) Avail: CASI HC A03/MF A01

Analog and digital methods for gain stabilization and gain-drift compensation in scintillator gamma-ray spectroscopy are discussed and compared. A digital method that uses gamma-ray reference sources (instead of alpha-particle reference sources embedded as seeds within the scintillators) and software (instead of hardware) for detecting and compensating for gain drifts can be applied to any scintillator spectrometer, including those with crystals that are too small to seed. Its applications extend to other types of gamma-ray detectors as well. The results of an experimental evaluation of this method, using a compact NaI(Tl) detector and gamma-ray spectra for plutonium of variable burnup, are presented. Reliable performance was demonstrated with changing total count rate, varying continuum background and changing gain. Applications for the method are discussed. DOE

**N93-19630#** Oak Ridge National Lab., TN.
**CHARGED PARTICLE TRACK RECONSTRUCTION USING ARTIFICIAL NEURAL NETWORKS**
C. Glover, P. Fu, T. Gabriel, and T. Handler (Tennessee Univ., Knoxville.) 1992 3 p Presented at the 10th Conference on Computing in High Energy Physics, Annecy, France, 21-25 Sep. 1992
(Contract DE-AC05-84OR-21400)
(DE93-003014; CONF-920966-11) Avail: CASI HC A01/MF A01

This paper summarizes the current state of our research in developing and applying artificial neural network (ANN) algorithm described here is based on a crude model of the retina. It takes as input the coordinates of each charged particle's interaction point ('hit') in the tracking chamber. The algorithm's output is a set of vectors pointing to other hits that are most likely to form a track. DOE

**N93-19746#** California Univ., Berkeley. Lawrence Berkeley Lab.
**HIGH RESOLUTION PHOTOELECTRON SPECTROSCOPY AND FEMTOSECOND INTRAMOLECULAR DYNAMICS USING SUPERSONIC MOLECULAR BEAMS Ph.D. Thesis**
B. Niu Sep. 1992 192 p
(Contract DE-AC03-76SF-00098)
(DE93-002555; LBL-32871) Avail: CASI HC A09/MF A02

High resolution He 1(alpha) photoelectron spectroscopy of formaldehyde and ketene and their deuterated compounds, are reported. The combination of a (H2CO) double-pass high-resolution electron-energy analyzer and effective rotational cooling of the sample by supersonic expansion enable the spectroscopy of these molecular cations. The vibrational autocorrelation functions are calculated from the high-resolution photoelectron spectra, shedding light on the ultrafast intramolecular dynamics of the molecular cations. This study reveals much more vibrational structural detail in the first electronic excited state of H2CO cations. The first electronic excited state of H2CO cations may have nonplanar equilibrium geometry. Strong isotope effects on vibronic (vibrational) coupling are observed in the second electronic excited state of H2CO. Vibrational autocorrelation functions are calculated for all four observed electronic states of H2CO. The correlation function of the first electronic excited state of H2CO shows a slow decay rate on the femtosecond time scale. The ultrafast decay of the H2CO cations in the third electronic excited state implies that dissociation and intramolecular processes are the main decay pathways. The present spectra of the ground states of ketene cations have more fine structure than before. The AIE's of the first and fifth excited states are determined unambiguously more accurately. The doublet-like fine structures present in the lint excited state of ketene implies the excitation of a 'soft' mode not observed before. The vibrational autocorrelation functions are calculated for 4 of the 6 observed electronic states. The dynamics of the ground states of the cations are characterized by a wave packet oscillating with small amplitude around the minimum on the upper PES. The decay dynamics of the first and the fifth excited states of ketene are characterized by ultra-fast intramolecular processes like predissociation. DOE

**N93-19748#** Argonne National Lab., IL.
**OVERVIEW OF HELIUM-LIKE STRUCTURE MEASUREMENTS: A FOCUS ON THE N = 2 TRIPLET STATES**
H. G. Berry and R. W. Dunford 1992 6 p Presented at the 6th International Conference on Physics of Highly Charged Ions, Manhattan, KS, 28 Sep. - 2 Oct. 1992
(Contract W-31-109-eng-38)
(DE93-002913; ANL/PHY/CP-77109; CONF-920948-7) Avail: CASI HC A02/MF A01

We present a comprehensive analysis of existing measurements of the 1s2s (sup 3)S(sub 1) - 1s2p (sup 3)P(sub 0,1,2) transition energies in heliumlike ions for nuclear charges Z=2 to Z=92. We find agreement with the standard unified calculations of Drake except for the transitions from the 1s2p (sup 3)P(sub 0) state. We find a deviation equal to 2.3x(Z/10)(exp 4) cm(exp -1) for the most precise existing measurements. DOE

**N93-19749#** Argonne National Lab., IL.
**MEASUREMENT OF THE CROSS-SECTION RATIO SIGMA(SUB N)/SIGMA(SUB p) IN INELASTIC MUON-NUCLEON SCATTERING AT VERY LOW x AND Q(SUP 2)**
V. Papavassiliou 1992 6 p Presented at the ICHEP-26: 26th International Union of Pure and Applied Physics (IUPAP) Conference on High Energy Physics, Dallas, TX, 6-12 Aug. 1992
(Contract W-31-109-eng-38)
(DE93-002916; ANL/PHY/CP-77536; CONF-920837-15) Avail: CASI HC A02/MF A01

Preliminary results are presented on the measurement of the cross-section ratio sigma(sub n)/sigma(sub p) inelastic micro N scattering obtained by the E-665 experiment using the Fermilab 490 GeV/c muon beam and liquid H(sub 2) and D(sub 2) targets. The results extend the previously measured x range by two orders of magnitude, down to 2 x 10(exp -5), at Q(sup 2) greater 10(exp -2) GeV(exp 2)/C(exp 2). The ratio is consistent with 1 throughout the new range. DOE

**N93-19750#** Argonne National Lab., IL. Engineering Physics Div.
**A SUGGESTION FOR SPECIFICATION OF THE NEUTRON ENERGY SCALE IN MEASUREMENTS, ANALYSES AND, EVALUATIONS OF DIFFERENTIAL REACTION CROSS-SECTION DATA**
D. L. Smith 1992 7 p Presented at the Symposium on Nuclear Data Evaluation Methodology, Upton, NY, 12-16 Oct. 1992
(Contract W-31-109-eng-38)
(DE93-002931; ANL/EP/CP-77792; CONF-921046-8) Avail: CASI HC A02/MF A01

Neutron energy distributions (spectra) in differential neutron cross section measurements are represented conventionally by giving the energies (not well defined) and full widths at half maximum of the spectra. In most modern experiments, it is possible for investigators to provide a much more thorough representation of neutron spectra. However, reporting such information would entail more numerical detail than appears practical to document. Therefore, it is suggested that such spectra be represented in publications and files of experimental data by providing the following four moments of each distribution: mean value (energy), standard deviation (resolution), skewness (asymmetry), and kurtosis (sharpness). Implementation of such a standard for data reporting would offer evaluators a much more complete and rational basis for comparing reported values and performing evaluations than previously possible. Some examples are provided to illustrate the concepts. DOE

**N93-19756#** Ohio State Univ., Columbus. Dept. of Chemistry.
**MOLECULAR ORBITAL STUDIES OF THE BONDING IN HEAVY ELEMENT ORGANOMETALLICS**
B. E. Bursten Dec. 1992 14 p
(Contract DE-FG02-86ER-13529)
(DE93-005291; DOE/ER-13529/7) Avail: CASI HC A03/MF A01

The upgrade to the DECstation 3100 (and other workstations underway) has enabled the use of more sophisticated electronic structure methods. Research was done in the following fields: tris(cyclopentadienyl) actinide complexes; actinide-containing molecules with metal-metal bonds (U dimer, Th-Ru, Zr-Ru); and applications of fully relativistic DV-X(alpha) method to trivalent actinide chemistry (MCl(sub 3)). DOE

**N93-19868#** Colorado State Univ., Fort Collins. Dept. of Chemistry.
**SOLVATION EFFECTS ON REACTIVE INTERMEDIATES: THE BENZYL RADICAL AND ITS CLUSTERS WITH Ar, N2, CH4, C2H6, AND C3H88**
R. Disselkamp and E. R. Bernstein 11 Dec. 1992 50 p

(Contract N00014-89-J-1237)
(AD-A258764; TR-82) Avail: CASI HC A03/MF A01

Mass resolved excitation spectra are presented for the benzyl radical and its clusters with Ar, N2, CH4, C2H6, and C3H8. The cluster spectra exhibit small red shifts (less than 50 cm(sup -1)) relative to the unclustered benzyl radical for the D(sub 1)(1(sup 2)A(sub 2)) reverse transition D(sub 0)(1(sup 2)B(sub 2)) and D(sub 2)(2(sup 2)B(sub 2) reverse transition D(sub 0)(1(sup 2)B(sub 2)) electronic transition regions. A unique set of low energy van der Waals modes is observed for these clusters for each excited electronic state investigated. The cluster spectra also reveal significant vibronic coupling between the two excited electronic states of the benzyl radical, as evidenced by a single vibrational predissociation threshold for each cluster. Ab initio calculations are performed on the benzyl radical to examine excited electronic state structure, predict transition energies, estimate ionization energy, and determine partial atomic charges in the electronic states of interest. The resulting partial charges are used in empirical atom-atom potential energy calculations to aid in the understanding of cluster spectroscopic shifts, binding energies, and van der Waals modes. GRA

**N93-18478#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**CHARACTERIZATION OF RADIATION DAMAGE IN SOLIDS**
R. A. Fields and T. S. Rose *In its* Aerospace Sponsored Research 1 Dec. 1991 p 66-68 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18483#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
**PICOSECOND MOLECULAR-BEAM STUDIES OF CHEMICAL REACTIVITY**
J. A. Syage and J. Steadman *In its* Aerospace Sponsored Research 1 Dec. 1991 p 79-82 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18491#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**CHAOTIC DYNAMICS OF ATOMS**
J. C. Camparo and R. P. Frueholz *In its* Aerospace Sponsored Research 1 Dec. 1991 p 101-105 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18494#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**SPIN EFFECTS IN ELECTRON-ATOM COLLISIONS**
B. Jaduszliwer and Y. C. Chan *In its* Aerospace Sponsored Research 1 Dec. 1991 p 110-113 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

## 73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory. For space radiation see *93 Space Radiation.*

**N93-17911#** Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Physics.
**HIGH ENERGY PHYSICS**
10 Apr. 1992 60 p
(Contract DE-FG02-91ER-40682)
(DE93-002411; DOE/ER-40682/17; CMU-04422) Avail: CASI HC A04/MF A01

The Counter Group continues to work on data analysis for Fermilab Experiment E653. Altogether, they expect several thousand reconstructed charm events and approximately 25 B pair events of which 12 have been observed thus far. Preparation continue for Fermilab Experiment E781, a high statistics study of charm barycn production. In the Theory Group, Cutkosky and collaborators study hadron phenomenology and non-perturbative QCD calculations. Levine has a long standing program in computational QED to obtain improved theoretical values for g-2 of the electron. Wolfenstein, Li, and their collaborators have worked on areas of weak interaction phenomenology that may yield insights beyond the standard model, e.g., CP violation and non-zero neutrino masses. Holman has been concerned with phase transitions in gauge theories relevant to cosmological problems. During 1991 most of the group effort was concentrated on the L3 experiment at CERN. Highlights of the results from the analysis of the Z degrees resonance include (1) a measurement of the strong coupling constant alpha(sub s) for b quarks, (2) a precision measurement of the average time of B hadrons, and (3) a direct determination of the number of light neutrino faculties from the reaction e(+)e(-) yields nu bar-nu gamma. We also began a major upgrade of the L3 luminosity monitor by replacing PWC chamber by a Si strip system in front of the BGO calorimeters. Finally we have continued our SSC R&D work on BaF2 by joining the GEM collaboration. DOE

**N93-17937#** Rome Univ. (Italy). Dipt. di Fisica.
**THE FIRST LEVEL ENERGY TRIGGER OF THE L3 EXPERIMENT/DESCRIPTION OF THE HARDWARE**
R. Bizzarri, F. Cesaroni (Istituto Nazionale di Fisica Nucleare, Rome, Italy), S. Gentile (Calabria Univ., Cosenza, Italy), G. Lunadei, M. Fukushima (Massachusetts Inst. of Tech., Cambridge.), and T. Hebbeker (European Organization for Nuclear Research, Geneva, Switzerland ) 15 Oct. 1991 37 p
(Nota-Interna-987; ETN-93-93351) Avail: CASI HC A03/MF A01

The design and the performance of the first level energy trigger, as used in the L3 experiment at LEP (Large Electron Positron) collider, are described. The trigger is based on energy measurements in the electromagnetic and hadronic calorimeters and the luminosity monitors. The bunch crossing time at LEP is 22.2 microseconds; the information from these detectors is digitized and analyzed in 20 microseconds. The trigger is a fast processor that makes use of about 350 CAMAC modules. Each of them performs a dedicated function and is connected with the other modules via front-panel buses. The CAMAC dataway is used only for initialization and checking purposes. The whole processor operates synchronously with a clock period of 60 ns. The trigger decision is mainly based on the total and electromagnetic energy in the event, on the cluster finding algorithm, which searches localized energy deposits in the calorimeters, and on the presence of a single photon, where the most of the electromagnetic energy is confined to a few crystals in the electromagnetic calorimeter. The system also includes the luminosity trigger, to detect small angle Bhabha events for the measurements of the luminosity. ESA

**N93-17940#** Rome Univ. (Italy). Dipt. di Fisica.
**MEASUREMENT OF THE HIT DISTRIBUTION IN RESISTIVE PLATE CHAMBERS EQUIPPED WITH A DIGITAL READ OUT OF THE CHARGE INDUCED ON STRIPS**
F. Ceradini (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), F. Lacava (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), G. Margutti (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), D. Orestano (Istituto Nazionale di Fisica Nucleare, Rome, Italy ), and L. Pontecorvo (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 9 Dec. 1991 17 p Presented at 77th Congresso Nazionale delle Societa Italiana di Fisica, L'Aquila, Italy, 1-5 Oct. 1991
(Nota-Interna-990; ETN-93-93354) Avail: CASI HC A03/MF A01

Measurement of the distribution of hits in Resistive Plate Chambers (RPC's) equipped with digital readout of the charge induced on strips of 31 mm pitch is reported. The probability that the pulses induced in the strips are over threshold is parametrized in terms of a charge density function and the parameters of the distribution are extracted from the data. Using the hit probability measured in a detailed simulation of the response of RPCs, the size of the clusters measured with a 70 GeV/c momentum muon beam could be reproduced. ESA

**N93-18032*#** Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
**NUCLEAR SAFETY FOR THE SPACE EXPLORATION INITIATIVE Final Report**
Terry E. Dix Nov. 1991 193 p
(Contract NAS3-25808)
(NASA-CR-189180; NAS 1.26:189180) Avail: CASI HC A09/MF A03

The results of a study to identify potential hazards arising from nuclear reactor power systems for use on the lunar and Martian surfaces, related safety issues, and resolutions of such issues by system design changes,

operating procedures, and other means are presented. All safety aspects of nuclear reactor power systems from prelaunch ground handling to eventual disposal were examined consistent with the level of detail for SP-100 reactor design at the 1988 System Design Review and for launch vehicle and space transport vehicle designs and mission descriptions as defined in the 90-day Space Exploration Initiative (SEI) study. Information from previous aerospace nuclear safety studies was used where appropriate. Safety requirements for the SP-100 space nuclear reactor system were compiled. Mission profiles were defined with emphasis on activities after low earth orbit insertion. Accident scenarios were then qualitatively defined for each mission phase. Safety issues were identified for all mission phases with the aid of simplified event trees. Safety issue resolution approaches of the SP-100 program were compiled. Resolution approaches for those safety issues not covered by the SP-100 program were identified. Additionally, the resolution approaches of the SP-100 program were examined in light of the moon and Mars missions. Author

**N93-18289#** Naval Research Lab., Washington, DC.
**IDENTIFICATION OF TOROIDAL FIELD ERRORS IN A MODIFIED BETATRON ACCELERATOR Interim Report**
P. Loschialpo, C. A. Kapetanakos, S. J. Marsh (SFA, Inc., Landover, MD.), L. K. Len (FM Technologies, Inc., Fairfax, VA.), and T. Smith (FM Technologies, Inc., Fairfax, VA.) 27 Nov. 1992 26 p
(AD-A257983; NRL/MR/4795-92-7141) Avail: CASI HC A03/MF A01

A newly developed probe has been used to detect errors in the toroidal magnetic field of the NRL modified betatron accelerator. Measurements indicate that the radial field components (errors) are 0.1 to 1 percent of the applied toroidal field. Such errors, in the typically 5 kG toroidal field, can excite resonances which drive the beam to the wall. Two sources of detected field errors are discussed. The first is due to the discrete nature of the twelve single turn coils which generate the toroidal field. Measurements and computer calculations indicate that it's amplitude varies from 0 to 0.2 percent as a function of radius. This error is a good suspect for causing the excitation of the damaging I is approximately equal to 12 resonance seen in our experiments. The other source of field error is due to the current feed gaps in the vertical magnetic field coils. A magnetic field is induced inside the vertical field coils' conductor in the opposite direction of the applied toroidal fields. Fringe fields at the gaps lead to additional field errors which have been measured as large as 1.0 percent. GRA

**N93-18654#** Technical Research Centre of Finland, Espoo. Reactor Lab.
**NON-CONVENTIONAL MEASUREMENT TECHNIQUES FOR THE DETERMINATION OF SOME LONG-LIVED RADIONUCLIDES PRODUCED ION NUCLEAR FUEL: LITERATURE SURVEY**
R. J. Rosenberg Apr. 1992 37 p Sponsored by Ministry of Trade and Industry
(VTT-TIED-1357; ISBN-951-38-4170-7; ETN-93-93068) Copyright Avail: CASI HC A03/MF A01

The results of a literature survey of nonradiometric analytical techniques for the determination of long lived radionuclides are described. The methods which were considered are accelerator mass spectrometry, inductively coupled plasma mass spectrometry, thermal ionization mass spectrometry, resonance ionization spectrometry, resonance ionization mass spectrometry, and neutron activation analysis. Neutron activation analysis was commonly used for the determination of I-129 and Np-237 in environmental samples. Inductively coupled mass spectrometry seems likely to become the method of choice for the determination of Tc-99, Np-237, and Pu isotopes. The methods are discussed and the chemical separation methods are described. ESA

**N93-18696#** Technical Research Centre of Finland, Espoo. Electrical and Automation Engineering Lab.
**PROBABILISTIC METHODS IN NUCLEAR POWER PLANT COMPONENT AGEING ANALYSIS [TODENNAKOISYYSMALLIT YDINVOIMALAITOSKOMPONENTTIEN VANHENEMISTUKIMUKSISSA]**
Kaisa Simola Mar. 1992 85 p Sponsored in part by Ministry of Trade and Industry
(VTT-Pubs-94; ISBN-951-38-4072-7; ETN-93-93071) Copyright Avail: CASI HC A05/MF A01

The purpose of the analysis is to ensure that the plant safety and reliability are maintained at a desired level through the designed, and a possibly extended, lifetime. The use of probabilistic models in the evaluation of the ageing of nuclear power plant components is discussed. The principles of nuclear power plant ageing studies are described and examples of ageing management programs are given. The use of time dependent probabilistic models to evaluate the ageing of various components and structures is described. The application of models is demonstrated with two case studies. In the case study of motor operated closing valves the analyses are based on failure data obtained from a power plant. In the example, the environmentally assisted crack growth is modeled with a computer code and the applicability of the model is evaluated on the basis of operating experience. ESA

**N93-18768#** Continuous Electron Beam Accelerator Facility, Newport New, VA.
**USE OF THE CEBAF ACCELERATOR FOR IR AND UV FREE ELECTRON LASERS**
J. J. Bisognano, D. Douglas, H. F. Dylla, L. Harwood, G. A. Krafft, C. W. Leemann, P. Liger, T. Mann, G. R. Neil, and D. V. Neuffer et al Aug. 1992 5 p
(Contract DE-AC05-84ER-40150)
(CEBAF-PR-92-023) Avail: CASI HC A01/MF A01; also available from CEBAF Library, 12000 Jefferson Ave., Newport News, VA 23606

The CEBAF superconducting linac is capable of accelerating electron beams suitable for driving high-power free-electron lasers (FEL's). The 45 MeV injector linac with a 6 cm period wiggler can produce kilowatt output powers of infrared light (3.6-17 microns), while the 400 MeV north linac can produce ultraviolet light (approximately 200 nm) at similar powers. The FEL's require the addition of a high-peak intensity electron source (approximately 60 A peak current) and extraction beam lines to wigglers with appropriate electron and photon optics. FEL operation is compatible with simultaneous baseline CEBAF nuclear physics operation. A design for a CEBAF-based FEL facility was developed. The current status of the FEL project is reported. Author

**N93-19471#** Harvard Univ., Cambridge, MA. High Energy Physics Lab.
**HARVARD UNIVERSITY HIGH ENERGY PHYSICS Progress Report**
1992 28 p
(Contract DE-FG02-91ER-40654)
(DE93-002091; DOE/ER-40654/2) Avail: CASI HC A03/MF A01

The principal goals of this work are to carry out forefront programs in high energy physics research and to provide first rate educational opportunities for students. The experimental program supported through HEPL is carried out at the major accelerator centers in the world and addresses some of the most important questions in high energy physics. The program is based at Harvard's High Energy Physics Laboratory, which has offices, computing facilities, and engineering support, including both electronics and machine shops. DOE

**N93-19495#** Stanford Linear Accelerator Center, CA.
**AN EXPERIMENTAL TEST OF THE LPM EFFECT: BREMSSTRAHLUNG SUPPRESSION AT HIGH ENERGIES**
S. Klein (California Univ., Santa Cruz.), M. Cavalli-Sforza (California Univ., Santa Cruz.), L. Kelley (California Univ., Santa Cruz.), P. Anthony (Lawrence Livermore National Lab., CA.), F. Dietrich (Lawrence Livermore National Lab., CA.), K. Vanbibber (Lawrence Livermore National Lab., CA.), R. Becker-Szendy, and R. Gearhart Nov. 1992 3 p Presented at the Meeting of the Division of Particles and Fields of the American Physics Society, Batavia, IL, 10-14 Nov. 1992
(Contract DE-AC03-76SF-00515)
(DE93-004019; SU-SLAC-PUB-5969; SCIPP-92/44; CONF-921122-3)
Avail: CASI HC A01/MF A01

An experiment at the Stanford Linear Accelerator Center (SLAC) to test the LPM (Landau-Pomeranchuk-Migda) effect is being prepared. In bremsstrahlung from high energy electrons, the longitudinal momentum transferred from the nucleus is very small. Then, by the uncertainty principle, the interaction must occur over a distance much larger than the atomic scale. In the LPM effect, multiple scattering changes the electron trajectory within the interaction distance, and so suppresses the bremsstrahlung. This effect, predicted in the 1950's, has never been quantitatively studied. For dense, high Z, targets in a 25 GeV electron beam, suppression is significant for photons below a few hundred MeV. By comparing

bremsstrahlung from targets of different materials (Pb, U, W, and C), it is possible to measure the suppression accurately. The longitudinal density effect, where very low energy photon emission is suppressed due to the dielectric effect of the medium, is studied. DOE

**N93-18637*#** Sverdrup Technology, Inc., Brook Park, OH. Lewis Research Center Group.
**NEAR TERM NEP MISSIONS AND SYSTEMS**
Jim Gilland *In* NASA, Lewis Researach Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 53-60 (For primary document see N93-18635 06-75)
Avail: CASI HC A02/MF A02

# 74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

**N93-17873#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**LIGHT DIFFUSION IN STOCHASTICALLY PERTURBED MEDIA**
M. Keijzer and A. J. Hermans 1992 26 p
(Rept-92-41; ETN-93-93132) Copyright Avail: CASI HC A03/MF A01

Traditionally, light distributions in scattering media are calculated using average optical parameters. But, for example in a medium like biological tissue, the optical parameters may vary widely within a small volume. Variations in the optical parameters cause variations in the light dose. Separately, four optical parameters are modeled at each point in the medium as stochastic samples of correlated Gaussian distributions. Using diffusion theory, the mean value and the standard deviation of the resulting stochastic fluence rate are quantified. The mean value differs only slightly from the fluence rate calculated with the average optical parameters. The standard deviation of the stochastic fluence rate is zero at the light source and increases almost exponentially with depth. Of the total reflection the standard deviation is zero but of the total transmission it is large. ESA

**N93-18088#** Washington State Univ., Pullman.
**THEORETICAL INVESTIGATIONS OF ULTRAFAST PHENOMENA IN CONDENSED MATTER Final Report, 1 Dec. 1989 - 30 Nov. 1992**
Thomas F. George Dec. 1992 14 p
(Contract N00014-90-J-1193)
(AD-A258496; WSU-92-93) Avail: CASI HC A03/MF A01

Theoretical models and computational codes have been developed to describe chemical and physical phenomena associated with solids, microstructure clusters and polymers, with special attention given to nonlinear optical effects and ultrafast processes. The following topics have been investigated: light-induced drift of electrons in semiconductor heterostructures; photoinduced electron transfer in coupled quantum wells; quantum beats in time-resolved luminescence spectra; scale-invariant theory of optical properties of fractals; optical properties of small silicon clusters; boron-nitrogen-substituted fullerenes; and nonlinear optical response in polymers irradiated by laser fields. GRA

**N93-18089#** Sparta, Inc., Lexington, MA.
**A HIGH FIDELITY SIMULATION OF OPTICAL DETECTION SYSTEMS, VOLUME 2 Final Report, 14 Aug. 1991 - 30 Nov. 1992**
N. R. Guivens, Jr. and P. D. Henshaw 30 Nov. 1992 46 p
(Contract N00014-90-C-0199)
(AD-A258498; LTR-92-016-Vol-2) Avail: CASI HC A03/MF A01

This report describes continued development of a sensor simulation code for high fidelity simulation of active and passive optical detection systems. The primary goal of this work has been to develop a toolbox of procedures which can be combined arbitrarily to model a wide variety of optical detector systems at the component, subsystem, and system level. The simulation is text file (script) driven, allowing libraries of detectors and detection systems to be assembled. The lowest level routines are primarily mathematical operations, and thus other systems, such as sensor signal processing, can also be modeled. The report provides an overview and results of model operation. Detailed descriptions of the noise model, the syntax of the modeling language, the available mathematical routines, and the prototype code structure are provided. GRA

**N93-18136#** Connecticut Univ., Storrs. Dept. of Electrical Engineering.
**NONLINEAR JOINT TRANSFORM CORRELATOR Final Report, Jun. 1989 - Apr. 1992**
Bahram Javidi Jun. 1992 41 p
(Contract F19628-89-K-0035)
(AD-A258329; RL-TR-92-141) Avail: CASI HC A03/MF A01

Experiments are provided to investigate the nonlinear joint transform correlator (JTC). Experiments are used to determine the correlation peak intensity, signal to noise ratio (SNR), peak to sidelobe ratio (PSR), and correlation width for various degrees of the nonlinearity used at the Fourier plane. The system is implemented using an optically addressed spatial light modulator in the Fourier plane. The experiments show that for the images used here, nonlinear compression of the joint power spectrum is necessary to pull the signal out of scene noise and produce a peak to sidelobe ratio of larger than unity. In addition, the sensitivity of the nonlinear JTC to the scaling and rotational changes of the input objects for various degrees of the nonlinearity applied to the joint power spectrum is investigated. The effect of the modulation transfer function of the spatial light modulator on the nonlinear JTC performance in the presence of multiple input targets is discussed. GRA

**N93-18174#** Rome Lab., Griffiss AFB, NY.
**TRACK-BEFORE-DECLARE METHODS IN IR IMAGE SEQUENCES**
Steven M. Bolen Sep. 1992 37 p
(AF Proj. 4506)
(AD-A257517; RL-TR-92-188) Avail: CASI HC A03/MF A01

The development of low observable (LO) targets, such as cruise missiles and cruise-missile-carrying aircraft, can severely stress the detection and tracking capabilities of infrared (IR) surveillance systems. Long-range surveillance requires the detection and tracking of targets that are spatially unresolved and often maneuvering in a low signal-to-clutter ratio (SCR) environment. These characteristics make the LO target difficult to detect in single-frame processing techniques. However, by combining intensity information from each pixel over many frames of data it is possible to improve target detection capability. A class of long-term integration techniques for weak target detection, known as track-before-declare (TBD), will be discussed in this paper. GRA

**N93-18183#** Hughes Research Labs., Malibu, CA.
**EHF FIBER OPTIC TRANSMITTER MODULE Final Technical Report**
R. R. Hayes Mar. 1992 115 p
(Contract F30602-88-C-0039)
(AD-A257586; RL-TR-92-28) Avail: CASI HC A06/MF A02

Some aspects of the theory of free-carrier-induced refractive index changes in semiconductors are covered. Additionally, some device structures aimed at exploiting this effect to provide for high frequency analog optical modulation are covered in this report. High optical loss and the requirement of large current changes at high frequencies prevented exploiting this effect initially at 10 GHz and then at greater than 30 GHz in the directional coupler architecture. A thermal switch was incidentally explored which had a risetime of 0.3 microseconds and required 0.8 watts to operate. GRA

**N93-18184#** Aerodyne Research, Inc., Billerica, MA.
**AN OPTICAL CONSENSUS CORRELATOR FOR CLUTTERED TARGETS Final Technical Report, Jun. 1991 - Jun. 1992**
Roger S. Putnam Aug. 1992 44 p
(Contract F19628-91-C-0106)
(AD-A257594; ARI-RR-934; RL-TR-92-218) Avail: CASI HC A03/MF A01

The phase-only Consensus Correlator improves the probability of detection of targets obscured by other objects such as a stand of trees. The technique involves masking out most of the input scene and using a standard correlator to search for small pieces of the expected target shape. The areas of the input scene that are found to contain pieces of the target are combined in a final correlation. The Consensus Correlator reduces the transfer of noise that is interspersed with pieces of the target in the input scene to the vicinity of the correlation spike in the correlation plane. A preliminary investigation of an appropriate figure of merit for comparing correlation spikes produced by different inputs and phase-only filters is also presented. GRA

**N93-18239#** Institute of Electrical and Electronics Engineers, New York, NY.
**PROCEEDINGS FOR OPTICAL FIBER SENSORS**
31 Jan. 1992 448 p Conference held in Monterey, CA, 29-31 Jan. 1992
(AD-A257801) Avail: CASI HC A19/MF A04

This conference is the eighth in the Optical Fiber Sensor (OFS) Series, the first being held in London in 1983. There has been considerable progress over the past nine years and recently a number of the technological hurdles which have slowed the development of this technology have been overcome. The number of commercially available fiber optic sensors is still growing, however workers in the fiber sensor area now have a better appreciation of the strengths of conventional sensor technology and realize the stiffness of the competition. However a number of workers in the user community, initially skeptical, are beginning to see the real advantages fiber optic sensor technology has to offer. It has always been the OFS conference charter to publish original, significant research in the area of fiber optic sensors. As the technology matures it is natural that emphasis shifts towards applications-oriented research and development. Since the last OFS conference, there have been a number of important demonstrations of fiber optic sensor technology - for example a 48 channel all optical towed array was successfully tested at sea by the U.S. Navy. In the area of fiber optic gyroscopes, progress has also been rapid towards the demonstration of the viability of this technology for wide ranging applications. As these areas mature a number of other applications--especially smart skins, are rapidly expanding. This gives opportunities for the development of new sensing and interrogation techniques. GRA

**N93-18247#** Aerospace Corp., El Segundo, CA. Space and Environmental Technology Center.
**EXACT CALCULATION OF LIGHT SCATTERING FROM A PARTICLE ON A MIRROR**
B. R. Johnson 15 Nov. 1992 29 p
(AD-A258464; ATR-92(8476)-1) Avail: CASI HC A03/MF A01

Exact methods have been developed for calculating light scattering from particles on a perfectly reflecting surface. The computed solutions obey Maxwell's equations and the appropriate boundary conditions. A brief discussion of the theory is followed by a presentation and discussion of selected scattering results. Comparisons are made with the predictions of Young's forward scatter Mie theory model. Under certain conditions, the exact results differ significantly from Mie theory. The exact differential cross sections exhibit large amplitude oscillations that are not predicted by Mie theory. The bidirectional reflectance distribution function (BRDF) is also calculated using exact scattering theory for both spherical and hemispherical particles that are both absorptive (complex index of refraction) and nonabsorptive (real index of refraction). These exact BRDF results are compared to the predictions of Young's model. GRA

**N93-18276*** National Aeronautics and Space Administration. Pasadena Office, CA.
**NEAR REAL-TIME STEREO VISION SYSTEM Patent**
Charles H. Anderson, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) and Larry H. Matthies, inventor (to NASA) 12 Jan. 1993 23 p Filed 18 Dec. 1991 Supersedes N92-17864 (30 - 8, p 1368)
(Contract NAS7-918)
(NASA-Case-NPO-18593-1-CU; US-Patent-5,179,441;
US-Patent-Appl-SN-812901; US-Patent-Class-358-88;
US-Patent-Class-358-133; Int-Patent-Class-H04N-13/00;
Int-Patent-Class-H04N-7/133) Avail: US Patent and Trademark Office

The apparatus for a near real-time stereo vision system for use with a robotic vehicle is described. The system is comprised of two cameras mounted on three-axis rotation platforms, image-processing boards, a CPU, and specialized stereo vision algorithms. Bandpass-filtered image pyramids are computed, stereo matching is performed by least-squares correlation, and confidence ranges are estimated by means of Bayes' theorem. In particular, Laplacian image pyramids are built and disparity maps are produced from the 60 x 64 level of the pyramids at rates of up to 2 seconds per image pair. The first autonomous cross-country robotic traverses (of up to 100 meters) have been achieved using the stereo vision system of the present invention with all computing done onboard the vehicle. The overall approach disclosed herein provides a unifying paradigm for practical domain-independent stereo ranging.
Official Gazette of the U.S. Patent and Trademark Office

**N93-18318#** Department of the Navy, Washington, DC.
**VARIABLE WIDE BAND FIBER OPTIC DELAY LINE Patent Application**
Gregory H. Ames, inventor (to Navy) 29 Jun. 1992 11 p
(AD-D015539; US-Patent-Appl-SN-905705) Avail: CASI HC A03/MF A01

Apparatus and method for a variable wide band fiber optic delay line is described. The apparatus comprises components that allow a user to select a delay time of a signal by the use of a wavelength tunable laser. The user selected wavelength determines the length that a light intensity signal corresponding to an electronic signal travels, thereby determining the time of delay. GRA

**N93-18335#** Naval Postgraduate School, Monterey, CA.
**DESIGN AND IMPLEMENTATION OF A FIBER OPTIC LINK FOR A TOKEN RING LOCAL AREA NETWORK M.S. Thesis**
Thomas J. Doran Sep. 1992 66 p
(AD-A257868) Avail: CASI HC A04/MF A01

This thesis describes the design and implementation of a fiber optic link for a token ring local area network (LAN). It features the use of fiber optic channels as the transmission medium between a computer system and a wiring concentrator to convert a physical ring design into a starwired configuration. The LAN was controlled by the TMS380 LAN Adapter chipset, which provided all diagnostic and network management features to include the 4 Mb/s electrical signal for operation. Since this adapter was developed for systems using twisted wire pair adapter cables, design modifications required that the fiber link be able to simulate impedance and current characteristics of copper wire link. This allows the use of adapter diagnostic checks for ring continuity and proper ring operation. Design evaluations using test signals and adapter signals from within the computer-concentrator link showed mixed results. All transmission objectives were met but the circuit loaded down the LAN adapter causing hardware error messages. GRA

**N93-18442#** Technische Univ., Delft (Netherlands).
**IMMERSION OBJECTIVE LENSES IN ELECTRON OPTICS Ph.D. Thesis**
Michal Lenc 1992 88 p
(ETN-92-92799) Avail: CASI HC A05/MF A01

A theoretical study of immersion objective lenses in electron optics is presented. Immersion objective lenses place the object inside high electrostatic and magnetic field, and thus they enable a significant improvement of the resolution. With this definition, cathode lenses belong to a class of electrostatic immersion objective lenses. Magnetic objective lenses of most commercial microscopes are also immersion lenses. The role of immersion objective lenses in electron optics is explained and the electron light optics analogy of these rational symmetric lenses is discussed. An overview of historical interest in these lenses is given. Mathematical tools are summarized: the perturbation theory for the optical eikonal calculation; the hamiltonian formulation of charged particle optics; and the wave optical description. The following are considered with respect to electrostatic immersion objective lenses and magnetic objective lenses: basic paraxial properties; the full set of aberration formulas for the third order geometrical and the first order chromatic aberrations; the resolution of immersion objectives by the axial aberrations. The results and aberration expression derived can be used for the optimization of objective lenses, for example the objective lens of the emission electron microscope or the scanning electron microscope with very low energy electrons. ESA

**N93-18957#** California Univ., San Diego, La Jolla.
**APPLICATION OF PHOTOREFRACTIVE CRYSTALS TO SOLVE MATRIX ALGEBRA PROBLEMS OPTICALLY Final Report**
Sing H. Lee 27 Oct. 1992 15 p
(Contract N00014-86-K-0697)
(AD-A259067) Avail: CASI HC A03/MF A01

The goals for the project are to solve matrix algebraic problems at high speed by applying photorefractive crystals in optical processing systems, and to study the photorefractives for such application. Although our interest was primarily on solving matrix algebraic problems, in order to improve system performance we found it important to optimize crystal operation

and to improve the photorefractive memory performance. For example, a fast response and large coupling gain bandwidth photorefractive amplifier is required in the matrix inversion system, and high photorefractive efficiency and large storage capacity are required for the correlation matrix-tensor multiplier system. The report is divided into four sections. Section 2.1 describes an all-optical implementation of an iterative algorithm for matrix inversion. Section 2.2 reports the implementation of a correlation matrix tensor multiplier algorithm in photorefractive crystals. Section 2.3 summarizes the results that have been obtained in improving photorefractive performance, which includes 450-cut BaTiO3, applying electrical field and moving grating on SBN and GaP. Section 2.4 reviews our work on photorefractive memory, which includes circulating memory, incremental recording, orthogonal phase encoding, and selective erasure. A list of publications resulted from the research is included at the end of this report. GRA

**N93-18995#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**INCREASING THE CORRECTED FIELD OF VIEW OF AN ADAPTIVE OPTICAL TELESCOPE Ph.D. Thesis**

Dustin C. Johnston Dec. 1992 137 p

(AD-A258816; AFIT/DS/ENG/92-06) Avail: CASI HC A07/MF A02

Current adaptive optical telescope designs use a single deformable mirror (DM) to compensate for atmospheric distortion. The corrected field of view (FOV) of an adaptive optics system could be increased through the use of multiple DM's optically conjugated to corresponding planes which sample the turbulence region in altitude. Often, the atmospheric turbulence responsible for the degradation of telescope images is concentrated in several layers. Each DM would correct for the component of the total wavefront in the pupil contributed by one or more layers. If the atmosphere does not possess a layered structure, the best fit of the turbulence profile can be made to a layered model. This dissertation describes and analyzes two novel methods for estimating the proper DM surfaces which would result in wide-FOV compensation. Both methods use multiple wavefront sensor measurements to estimate the three-dimensional turbulence structure. The wavefront measurements are made using artificial guide stars created by scattered laser light. The analysis includes the effects of noise, realistic models of systems components, and the limitations of artificial guide stars. It is shown that multiple-DM, multiple-guide-star systems can significantly increase the compensated FOV relative to single-DM, single-guide star systems. GRA

**N93-19052*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**FAULT-TOLERANT FIBER OPTIC BACKPLANE Patent Application**

Daniel L. Palumbo, inventor (to NASA) 19 Oct. 1992 30 p

(NASA-Case-LAR-14785-1; NAS 1.71:LAR-14785-1;

US-Patent-Appl-SN-963170) Avail: CASI HC A03/MF A01

A fault-tolerant, fiber optic interconnect, or backplane, which serves as a via for data transfer between modules is presented. Fault tolerance algorithms are embedded in the backplane by dividing the backplane into a read bus and a write bus and placing a redundancy management unit (RMU) between the read bus and the write bus so that all data transmitted by the write bus is subjected to the fault tolerance algorithms before the data is passed for distribution to the read bus. The RMU provides both backplane control and fault tolerance. NASA

**N93-19069#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**THE EFFECT OF AN ADAPTIVE OPTICAL SYSTEM'S SPATIO-TEMPORAL RESPONSE ON IMAGING PERFORMANCE M.S. Thesis**

Patrick M. Harrington Dec. 1992 49 p

(AD-A258848; AFIT/GEO/ENG/92D-06) Avail: CASI HC A03/MF A01

Ideally, an adaptive optical control system would have instantaneous temporal response and infinite spatial bandwidth. In real systems, the response time of the adaptive optical control system is limited by the integration time of the wave front sensor, the computational time of the control algorithm, and the actuator response time. Additionally, finite inter-actuator spacing limits the deformable mirror's ability to reproduce spatial frequencies having a period less than twice this spacing. Although analyses general enough to account for both the temporal and spatial characteristics of the adaptive optical system exist, they are complex and require detailed information regarding the wave front sensor, the deformable mirror, and the control algorithm. A frequency domain model that describes performance effects of an adaptive optical system's temporal response taking into account aperture piston and tilt removal and spatial bandwidth limitations due to finite subaperture size is developed. The unique aspect of this model is the relative ease with which performance characteristics of different spatial and temporal system response functions can be investigated. GRA

**N93-19333#** Hughes Research Labs., Malibu, CA.

**STIMULATED PHOTOREFRACTIVE OPTICAL NEURAL NETWORKS Final Report, 29 Sep. 1989 - 31 Oct. 1992**

Y. Owechko, G. Dunning, G. Nordin, and B. H. Soffer 15 Dec. 1992 130 p

(Contract N00014-89-C-0274)

(AD-A258825) Avail: CASI HC A07/MF A02

This final report describes research in optical neural networks performed under DARPA sponsorship at Hughes Aircraft Company during the period 1989-1992. The objective of demonstrating a programmable optical computer for flexible implementation of multi-layer neural network models was successfully achieved. The advantages of optics for neural network implementations include large storage capacity, high connectivity, and massive parallelism which result in high computation rates. The optical neurocomputer developed on this program is based on a new type of holography, cascaded grating holography (CGH), in which the neural network weights are distributed among angularly- and spatially-multiplexed gratings generated by stimulated processes in photorefractive crystals. This approach reduces crosstalk and improves the utilization of the optical input device. Successfully implemented neural networks include the Perceptron, Bidirectional Associative Memory, and multi-layer backpropagation networks. Up to 104 neurons, 2x10(7) weights, and processing rates of 2x10(7) connection updates per second were achieved. Packaging concepts for future versions of the neurocomputer were also studied. GRA

**N93-19346*#** Rensselaer Polytechnic Inst., Troy, NY. Center for Intelligent Robotic Systems for Space Exploration.

**EFFICIENT VISUAL GRASPING ALIGNMENT FOR CYLINDERS**

Keith E. Nicewarner and Robert B. Kelley Dec. 1991 13 p

(Grant NAGw-1333)

(NASA-CR-191863; NAS 1.26:191863; CIRSSE-110) Avail: CASI HC A03/MF A01

Monocular information from a gripper-mounted camera is used to servo the robot gripper to grasp a cylinder. The fundamental concept for rapid pose estimation is to reduce the amount of information that needs to be processed during each vision update interval. The grasping procedure is divided into four phases: learn, recognition, alignment, and approach. In the learn phase, a cylinder is placed in the gripper and the pose estimate is stored and later used as the servo target. This is performed once as a calibration step. The recognition phase verifies the presence of a cylinder in the camera field of view. An initial pose estimate is computed and uncluttered scan regions are selected. The radius of the cylinder is estimated by moving the robot a fixed distance toward the cylinder and observing the change in the image. The alignment phase processes only the scan regions obtained previously. Rapid pose estimates are used to align the robot with the cylinder at a fixed distance from it. The relative motion of the cylinder is used to generate an extrapolated pose-based trajectory for the robot controller. The approach phase guides the robot gripper to a grasping position. The cylinder can be grasped with a minimal reaction force and torque when only rough global pose information is initially available. Author

**N93-19374*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**OPTICAL FIBER STRAIN SENSOR WITH IMPROVED LINEARITY Patent Application**

Claudio Oliveira Egalon, inventor (to NASA) (Analytical Services and Materials, Inc., Hampton, VA.) and Robert S. Rogowski, inventor (to NASA) 21 Dec. 1992 10 p

(NASA-Case-LAR-14857-1-SB; NAS 1.71:LAR-14857-1-SB;

US-Patent-Appl-SN-994593) Avail: CASI HC A02/MF A01

A strain sensor is constructed from a two mode optical fiber. When the optical fiber is surface mounted in a straight line and the object to which

the optical fiber is mounted is subjected to strain within a predetermined range, the light intensity of any point at the output of the optical fiber will have a linear relationship to strain, provided the intermodal phase difference is less than 0.17 radians. NASA

**N93-19511#** Brookhaven National Lab., Upton, NY.
**SYNCHROTRON RADIATION SOURCES AND CONDENSERS FOR PROJECTION X RAY LITHOGRAPHY**
J. B. Murphy, A. A. MacDowell, D. L. White (Bell Telephone Labs., Inc., Murray Hill, NJ.), and O. R. Wood, II (Bell Telephone Labs., Inc., Holmdel, NJ.) 1992 29 p Presented at the Soft X Ray Projection Lithography Topical Meeting, Monterey, CA, 6-8 Apr. 1992
(Contract DE-AC02-76CH-00016)
(DE93-002964; BNL-48033; CONF-9204120-4) Avail: CASI HC A03/MF A01

The design requirements for a compact electron storage ring that could be used as a soft x-ray source for projection lithography are discussed. The design concepts of the x-ray optics that are required to collect and condition the radiation in divergence, uniformity and direction to properly illuminate the mask and the particular x-ray projection camera used are discussed. Preliminary designs for an entire soft x-ray projection lithography system using an electron storage ring as a soft X-ray source are presented. It is shown that by combining the existing technology of storage rings with large collection angle condensers, a powerful and reliable source of 130 A photons for production line projection x-ray lithography is possible. DOE

**N93-19794#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**IMAGE QUALITY MEASUREMENT TECHNIQUES [TECNICAS PARA MEDIDAS DE QUALIDADE DE UMA IMAGEM]**
Otavio Santos Cupert Durao 1992 17 p In PORTUGESE
(INPE-5362/NTC/302) Avail: CASI HC A03/MF A01

Quantitative measurements of the quality of an image processed digitally seek to reflect the subjective judgment made by humans. This study discusses some of these techniques from the simplest to those which contemplate modeling of the human vision system; techniques are shown for measuring the quality of monochromatic images. An example of an application drawn from the literature is given. Transl. by FLS

**N93-19947#** Optical Society of America, Washington, DC.
**ORGANIZATION OF THE OPTICAL SOCIETY OF AMERICA PHOTONIC SCIENCE TOPICAL MEETING SERIES (1991), VOLUME 16. CONFERENCE EDITION: SUMMARIES OF PAPERS PRESENTED AT THE PERSISTENT SPECTRAL HOLE-BURNING: SCIENCE AND APPLICATIONS TOPICAL Final Report, 1 Jan. - 31 Dec. 1991**
Jarus W. Quinn 22 May 1992 338 p Meeting held in Monterey, CA, 26-28 Sep. 1991
(Grant AF-AFOSR-0176-91)
(AD-A258663; AFOSR-92-0514TR) Avail: CASI HC A15/MF A03

A list of reports presented at the Optical Society of America conference is given. The reports cover the following topics: photorefractive materials, effects, and devices; integrated photonics research; nonlinear guided wave phenomena; optical amplifiers and their applications; optical computing; picosecond electronics and optoelectronics; quantum optoelectronics; photonic switching microphysics of surfaces; beam induced processes; soft x-ray projection lithography; short wavelength coherent radiation--generation and applications; and persistent spectral hole-burning--science and applications. GRA

**N93-18468#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**ADVANCED ATOMIC FILTERS**
J. A. Gelbwachs and Y. C. Chan *In its* Aerospace Sponsored Research 1 Dec. 1991 p 31-34 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18471#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**STIMULATED BRILLOUIN SCATTERING PHASE CONJUGATION**
S. T. Amimoto and R. F. W. Gross *In its* Aerospace Sponsored Research 1 Dec. 1991 p 43-46 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18474#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**INFRARED SENSOR TECHNOLOGY AND APPLICATIONS**
R. W. Russell and G. S. Arnold *In its* Aerospace Sponsored Research 1 Dec. 1991 p 51-53 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18475#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**PICOSECOND STUDIES OF SPACE OPTICAL MATERIALS**
S. C. Moss *In its* Aerospace Sponsored Research 1 Dec. 1991 p 53-56 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18826*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**MICRO-PRECISION CONTROL/STRUCTURE INTERACTION TECHNOLOGY FOR LARGE OPTICAL SPACE SYSTEMS**
Samuel W. Sirlin and Robert A. Laskin *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 115-131 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

**N93-18832*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**INTEGRATED MODELING OF ADVANCED OPTICAL SYSTEMS**
Hugh C. Briggs, Laura Needels, and B. Martin Levine *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 207-213 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

**N93-18834*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE JPL PHASE B INTERFEROMETER TESTBED**
Daniel B. Eldred and Mike ONeal *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 231-237 (For primary document see N93-18818 06-18)
Avail: CASI HC A02/MF A04

**N93-18940*#** Lockheed Missiles and Space Co., Palo Alto, CA. Research Lab.
**MODAL CHARACTERIZATION OF THE ASCIE SEGMENTED OPTICS TESTBED: NEW ALGORITHMS AND EXPERIMENTAL RESULTS**
Alain C. Carrier and Jean-Noel Aubrun *In* NASA. Langley Research Center, The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 2 Feb. 1993 p 665-705 (For primary document see N93-18928 06-18)
Avail: CASI HC A03/MF A03

**N93-19408*#** New York Inst. of Tech., NY. Electrical Engineering Dept.
**DESIGN AND EVALUATION OF FDDI FIBER OPTICS NETWORKFOR ETHERNETS, VAX'S AND INGRAPH WORK STATIONS**
M. Chris Wernicki *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 501-529 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

**N93-19409*#** University of Central Florida, Orlando. Dept. of Electrical and Computer Engineering Technology.
**INVESTIGATION OF THE BANDWIDTH OF MULTIMODE OPTICAL FIBERS USED WITH 1550-nm LED AND LASER SOURCES**
Preston A. White, III *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 531-559 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

# 75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

**N93-17947#** Swedish Inst. of Space Physics, Kiruna.
**[ACTIVITIES REPORT OF THE INSTITUTE OF SPACE PHYSICS] Annual Report, 1991**
Lars Eliasson, ed. 1992 68 p
(ETN-93-93360) Avail: CASI HC A04/MF A01

Activities at the Swedish Institute of Space Physics (IRF), whose main task is to conduct research and perform observatory measurements in the field of space physics, are addressed. Additionally, the IRF also provides education in space physics. Facts about the IRF and its board, staff, finances, and personnel are given. The research carried out in the four divisions is reviewed. The research covers the following topics: hot magnetospheric plasma investigations; research in the field of mechanical waves, especially concerning infrasound and vibration; space plasma theory, with an emphasis on plasma waves and wave particle interactions in the magnetosphere; experimental studies of waves and wave interactions in space plasmas; and electrodynamic processes related to ionosphere magnetosphere coupling. The observatory program which carried out ground based observations in Kiruna, Lycksele, and Uppsala (Sweden) is reviewed, as is the educational program. Committee appointments, participation in conferences and contributions, and publication and reports of 1991 are also addessed. ESA

**N93-18020#** Energy/Matter Conversion Corp., Manassas, VA.
**PHENOMENOLOGICAL MODELLING OF POLYWELL (TM) SCIF MULTI-CUSP INERTIAL-ELECTROSTATIC CONFINEMENT SYSTEMS**
Robert W. Bussard and Katherine E. King 1992 22 p
(Contract MDA972-90-C-0006)
(AD-A257944; EMC2-1191-02) Avail: CASI HC A03/MF A01

In an earlier paper, a comprehensive study was made of the recirculation and losses of electrons in their flow through simple inverse power-law potential wells bounded by similarly inverse power-law dependent magnetic fields. This study examined electron flow and loss behavior in the simplest approximation invoked to describe Polywell(tm) confinement systems. The importance of this study, and of the present paper, is that the power balance in Polywell(tm) systems is determined entirely by the rate of electron losses; if these are large, then the system can not yield net power. A large body of work has been undertaken over the past 35 or so years in the study of general cusp confinement of plasmas. Nearly all of this has examined single particle electron (or ion) motion or the motion of particles in neutral plasmas within cusped magnetic systems, generally without internal electric potential fields. Furthermore, almost all of this work on plasmas has been limited to plasmas in local thermodynamic equilibrium (LTE); non applied to non-neutral systems. GRA

**N93-18100#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**A LOW VELOCITY APPROXIMATION FOR THE RELATIVISTIC VLASOV-MAXWELL SYSTEM Ph.D. Thesis**
Donald J. McGillen Jun. 1992 108 p
(AD-A258300; AFIT/CI/CIA-92-021D) Avail: CASI HC A06/MF A02

The Relativistic Vlasov-Maxwell (RVM) system is a nonlinear system of first order partial differential equations that models the time evolution of a collisionless plasma, e.g., a high temperature, low density ionized gas. Numerical computation of solutions of this system is prohibitively expensive in part because of the six-dimensional phase space for the Vlasov density function. For computational feasibility, we consider a version (RVM) in which the Vlasov density f depends on one spatial variable, x, and two momentum variables, v sub 1 and v sub 2. This is the simplest version of the problem which retains the hyperbolic structure of Maxwell's equations and for which there is a nontrivial magnetic field. GRA

**N93-18244#** Directed Technologies, Inc., Arlington, VA.
**COLLISIONAL RELAXATION OF NON-MAXWELLIAN PLASMA DISTRIBUTION IN A POLYWELL (TM)**
M. Rosenberg (Energy/Matter Conversion Corp., Manassas, VA.) and Nicholas A. Krall (Krall Associates, Del Mar, CA.) Jun. 1992 46 p
(AD-A257651; EMC2-0692-03) Avail: CASI HC A03/MF A01

The Polywell is a magnetic version of a Spherically Convergent Ion Focus (SCIF) device which was proposed as a significant variation of earlier studies on electrostatic confinement. The idea of this device is to inject high energy electrons into a quasi-spherical magnetic field; the electrons create a potential well of sufficient depth to accelerate ions from low energy at the periphery to fusion energies within a focus at the center of the sphere. Injection of electrons keeps the system electrically nonneutral, so that the potential well which accelerates the ions is maintained at a constant value sufficient to confine the ions within the device, returning them again and again at high velocity to the central focus. Essential to the success of the scheme is that the ions maintain their nonthermal velocity distribution, with primarily radial flow, long enough to produce fusion in the dense focus at the center of the sphere. GRA

**N93-18245#** Directed Technologies, Inc., Arlington, VA.
**EFFECTIVE GYRO HOLE LOSS RADIUS AND DIAMAGNETIC LIMIT IN POLYWELL (TM) SYSTEMS**
Robert W. Bussard (Energy/Matter Conversion Corp., Manassas, VA.) 14 Oct. 1992 5 p
(Contract MDA972-90-C-0006)
(AD-A257689) Avail: CASI HC A01/MF A01

Electron gyromagnetic motion parallel to the external surface can (and will) produce internal currents that create magnetic fields of opposite sign to that of the externally-driven cusp field. Only those electrons whose gyro orbits encircle the cusp axis have any net effect on this process. The volume of the diamagnetically-effective electrons is bounded roughly by a torus of major and minor radius equal to the gyro radius in the effective cusp field. GRA

**N93-18323#** Bari Univ. (Italy).
**NATO ADVANCED RESEARCH WORKSHOP ON NON-THERMAL PLASMA TECHNIQUES FOR POLLUTION CONTROL**
25 Sep. 1992 179 p Workshop held in England, 21-25 Sep. 1992
(Contract DAJA-45-92-M-0115)
(AD-A258477; R/D-6867-CH-02) Avail: CASI HC A09/MF A02

Acid rain, global warming, ozone depletion, and smog are preeminent environmental problems facing the world today. Non-thermal plasma techniques offer an innovative approach to the cost-effective solution of these problems. Many potential applications of non-thermal plasmas to air pollution control have already been demonstrated. On 21-25 Sept. 1992, leading experts from academia, government laboratories, and industry met at Cambridge University, England to discuss laboratory studies and industrial implementation of non-thermal plasmas for the abatement of hazardous gaseous wastes. Papers presented at the workshop are included. L.R.R.

**N93-18404*#** Alabama Univ., Huntsville. Center for Space Plasma and Aeronomic Research.
**SPACE PLASMA PHYSICS RESEARCH Final Report, 1 Jul. 1989 - 30 Dec. 1992**
Richard H. Comfort and James L. Horwitz Jan. 1993 11 p
(Grant NAG8-134)
(NASA-CR-192158; NAS 1.26:192158) Avail: CASI HC A03/MF A01

During the course of this grant, work was performed on a variety of topics and there were a number of significant accomplishments. A summary of these accomplishments is included. The topics studied include empirical model data base, data reduction for archiving, semikinetic modeling of low energy plasma in the inner terrestrial magnetosphere and ionosphere, O(+) outflows, equatorial plasma trough, and plasma wave ray-tracing studies. A list of publications and presentations which have resulted from this research is also included. Author

**N93-18407#** Dartmouth Coll., Hanover, NH.
**NONLINEAR MAGNETOHYDRODYNAMICS**
1992 5 p
(Contract DE-FG02-85ER-53194)
(DE93-003241; DOE/ER-53194/5) Avail: CASI HC A01/MF A01

Theoretical predictions were compared with available data from JET on the threshold unstable MHD activity in toroidal confinement devices. In particular, questions arising as to Hartmans number and the selection of a kinematic viscosity are discussed. DOE

**N93-18421#** National Inst. for Fusion Science, Nagoya (Japan).
**ELECTROSTATIC POTENTIAL IN A COLLISIONLESS PLASMA FLOW ALONG OPEN MAGNETIC FIELD LINES**
K. Sato (Himeji Inst. of Tech., Japan ), H. Katayama (Himeji Inst. of Tech., Japan ), and F. Miyawaki (Himeji Inst. of Tech., Japan ) Jun. 1992 29 p Submitted for publication
(NIFS-155) Avail: CASI HC A03/MF A01

Formation of the steady-state potential in a collisionless plasma flow along nonuniform magnetic field lines terminated at a wall is studied theoretically under the condition that a particle source in a plasma can be neglected. It is found that the plasma flow is required to satisfy the generalized Bohm criterion over the whole region for the formation of the steady-state continuous potential in the divergent magnetic field. A monotonically falling potential can build up from the inside of the magnetic throat to the wall only if the Bohm criterion is marginally satisfied at the throat. Numerical solutions to Poisson's equation show that a potential profile outside the throat is strongly dependent upon the particle density of electrons trapped between the throat and the wall. Controllability of the potential by increasing the trapped-electron density is discussed briefly. Author

**N93-18511#** General Atomic Co., San Diego, CA.
**BIAS-SUSTAINED SHIELD PLASMA**
G. M. Staebler, A. W. Hyatt, M. J. Schaffer, and M. A. Mahdavi Sep. 1992 13 p Presented at the International Atomic Energy Agency (IAEA) Technical Committee Meeting on Tokamak Plasma Biasing, Montreal, Ontario, 8-10 Sep. 1992
(Contract DE-AC03-89ER-51114)
(DE93-001908; GA-A-21041; CONF-9209181-2) Avail: CASI HC A03/MF A01

Divertor biasing may provide a method for density and impurity control by enhancing the shielding efficiency of the scrape-off layer. The idea is to make the scrape-off plasma denser and thicker by heating it with a bias-driven current, and by inducing a radial E x B drift. If the bias is applied to flux surfaces at the outer edge of the usual scrape-off layer, a new layer of plasma can be added which is sustained by the bias-supplied power. A simple theoretical model is presented which shows that there is a threshold condition which must be satisfied in order for the bias-heated plasma to be self-sustaining. The bias-sustained plasma must also be opaque enough to neutrals in order for it to be fueled by a gas puff, which means that it will serve as a shield to the core plasma against neutral impurities and hydrogen. Experiments performed on D3-D have demonstrated both a modification of the central nickel impurity concentration and an increase in the ionization of hydrogen within the scrape-off layer due to biasing. DOE

**N93-18635*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SECOND MAGNETOPLASMADYNAMIC THRUSTER WORKSHOP**
1992 167 p Workshop held in Cleveland, OH, 19 May 1992
(RTOP 506-42-31)
(NASA-CP-10109; E-7369; NAS 1.55:10109) Avail: CASI HC A08/MF A02

The meeting focused on progress made in establishing performance and lifetime expectations of magnetoplasmadynamic (MPD) thrusters as functions of power, propellant, and design; models for the plasma flow and electrode components; viability and transportability of quasi-steady thruster testing; engineering requirements for high power, long life thrusters; and facilities and their requirements for performance and life testing. For individual titles, see N93-18636 through N93-18645.

**N93-18636*#** National Aeronautics and Space Administration, Washington, DC.
**TRANSPORTATION AND PLATFORMS PERSPECTIVE** **c12**
Gary L. Bennett *In* NASA, Lewis Research Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 41-51 (For primary document see N93-18635 06-75)
Avail: CASI HC A03/MF A02

The topics covered are presented in viewgraph form and include the following: Office of Aeronautics and Space Technology; space research and technology (R&T); space R&T mission statement; Space R&T program development; R&T strategy; Office of Space Science and Applications (OSSA) technology needs; transportation technology; and space platforms technology. Author

**N93-18637*#** Sverdrup Technology, Inc., Brook Park, OH. Lewis Research Center Group.
**NEAR TERM NEP MISSIONS AND SYSTEMS** **c73**
Jim Gilland *In* NASA, Lewis Researach Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 53-60 (For primary document see N93-18635 06-75)
Avail: CASI HC A02/MF A02

The topics covered are presented in viewgraph form and include the following: Nuclear Propulsion Office Nuclear Electric Propulsion (NEP) goals; near term systems definition, representative near term NEP systems; demonstration missions; primary missions; near term NEP Mars cargo mission; near term NEP Mars mission analysis; and near term NEP mars mission. Author

**N93-18638*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE MPD THRUSTER PROGRAM AT JPL**
Keith Goodfellow, Tom Pivirotto, and Jay Polk *In* NASA, Lewis Researach Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 61-70 (For primary document see N93-18635 06-75)
Avail: CASI HC A02/MF A02

The topics covered are presented in viewgraph form and include the following: engine lifetime assessment; lithium magnetoplasmadynamic (MPD) thruster development; and radiation-cooled, applied-field engine testing. Author

**N93-18639*#** Sverdrup Technology, Inc., Brook Park, OH. Lewis Research Center Group.
**MPD THRUSTER TECHNOLOGY**
Roger M. Myers *In* NASA, Lewis Research Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 71-90 (For primary document see N93-18635 06-75)
Avail: CASI HC A03/MF A02

The topics are presented in viewgraph form and include the following: in house program elements; performance measurements; applied-field magnetoplasmadynamic (MPD) thruster performance scaling; MPD thruster technology; thermal efficiency scaling; anode fall voltage measurements; anode power deposition studies; MPD thruster plasma modeling; MPD thruster lifetime studies; and MPD thruster performance studies. Author

**N93-18640*#** Los Alamos National Lab., NM.
**LOS ALAMOS RESEARCH IN NOZZLE BASED COAXIAL PLASMA THRUSTERS**
Jay Scheuer, Kurt Schoenberg, Richard Gerwin, Ivars Henins, Ronald Moses, Jr., and Glen Wurden *In* NASA, Lewis Research Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 91-100 (For primary document see N93-18635 06-75)
Avail: CASI HC A02/MF A02

The topics are presented in viewgraph form and include the following: research approach; perspectives on efficient magnetoplasmadynamic (MPD) operation; NASA and DOE supported research in ideal magnetohydrodynamic plasma acceleration and flow, electrode phenomena, and magnetic nozzles; and future research directions and plans. Author

**N93-18641*#** Massachusetts Inst. of Tech., Cambridge.
**REVIEW OF RECENT WORK ON MPD THRUSTERS AT MIT**
Daniel Hastings *In* NASA, Lewis Research Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 101-116 (For primary document see N93-18635 06-75)
Avail: CASI HC A03/MF A02

The topics are presented in viewgraph form and include the following: basic philosophy of MIT SSPL work; 2-D numerical magnetoplasmadynamic (MPD) simulations; analysis of MPD boundary layers; and ignition of MPD thrusters. Author

**N93-18642*#** Ohio State Univ., Columbus.
**MAGNETOPLASMADYNAMIC THRUSTER FLOWS: PROBLEMS AND PROGRESS**
Peter J. Turchi *In* NASA, Lewis Research Center, Second

Magnetoplasmadynamic Thruster Workshop 1992 p 117-132 (For primary document see N93-18635 06-75)
Avail: CASI HC A03/MF A02

The topics are presented in viewgraph form and include the following: overall strategy for magnetoplasmadynamic (MPD) thruster development; high power MPD flows; moderate power MPD thrusters and components; qualitative spectroscopic studies of magnetic nozzle flow; hollow cathode studies; and anode flow studies. Author

**N93-18643*#** Ohio State Univ., Columbus.
**SCALING AND APPLIED FIELD STUDIES OF MPD THRUSTERS WITH LASER DIAGNOSTICS**
Thomas M. York *In* NASA, Lewis Research Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 133-136 (For primary document see N93-18635 06-75)
Avail: CASI HC A01/MF A02

The topics are presented in viewgraph form and include the following: self-field magnetoplasmadynamics; 1/4-scale applied-field MPD; scaling of arcs and MPD-arcs; magnetic nozzle studies; advanced diagnostic techniques needed for obtaining particle velocity, temperature, and current distributions in plasma thrusters; nonintrusive laser diagnostics for arcs and MPD-arcs; and schematic of multi-beam interferometer for electron density profile determination. Author

**N93-18644*#** Phillips Lab., Edwards AFB, CA.
**OL-AC PHILLIPS LABORATORY MPD THRUSTER RESEARCH PROGRAM**
Dennis L. Tilley *In* NASA, Lewis Research Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 137-140 (For primary document see N93-18635 06-75)
Avail: CASI HC A01/MF A02

The topics are presented in viewgraph form and include the following: facility construction; quadruple langmuir probe measurements; hollow/porous anode magnetoplasmadynamic (MPD) thruster; the measurement of the ionization fraction inside of the MPD thruster; and the experimental investigation of the effects of microturbulence on MPD thruster performance. Author

**N93-18645*#** Princeton Univ., NJ.
**RECENT ADVANCES IN MPD THRUSTER RESEARCH AT PRINCETON**
Robert G. Jahn and Edgar Y. Choueiri *In* NASA, Lewis Research Center, Second Magnetoplasmadynamic Thruster Workshop 1992 p 141-160 (For primary document see N93-18635 06-75)
Avail: CASI HC A03/MF A02

A summary of last years anode, plasma, and cathode findings is presented. A summary of this years activities and findings is also presented. A brief discussion of previous and current understanding is given and covers the following topics: existence of microinstabilities; the scaling of Va with the Hall parameter; the scaling of anomalous resistivity with the Hall parameter; the relation between anomalous resistivity and the anode drop; the presence of turbulence in the anode region; numerical simulation with anomalous transport; the use of magnets to decrease dissipation; performance testing with the new anode; the mechanisms behind the ionization sink; and lithiated cathode research. Author

**N93-18707#** Oak Ridge National Lab., TN.
**POLOIDAL FLOW GENERATION BY RESISTIVE PRESSURE-GRADIENT-DRIVEN TURBULENCE**
L. Garcia (Universidad Complutense, Madrid, Spain ), B. A. Carreras, V. E. Lynch, and P. H. Diamond (California Univ., San Diego.) 1992 9 p Presented at the 14th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Wuerzburg, Germany, 30 Sep. - 7 Oct. 1992
(Contract DE-AC05-84OR-21400)
(DE93-001638; CONF-920913-18) Avail: CASI HC A02/MF A01

The radial structure of poloidal flows and radial electric fields in the tokamak plasma edge plays an important role in determining global confinement properties. In a turbulent plasma, poloidal flow can be generated through the Reynolds stress. At the same time, this poloidal flow controls the level of fluctuations. Therefore, self-consistent calculations of plasma turbulence in the presence of flows are needed to identify the mechanism of confinement improvement. Here, we study the interaction between flows and turbulence for the case of resistive pressure-gradient-driven turbulence. Linearly, both the shear flow, V(sub theta)prime does not = 0, and the curvature flow, V(sub theta)double-prime does not = 0, are stabilizing. Nonlinearly, the effect of the shear flow is weak, while the curvature flow is robust and survives in the nonlinear regime. DOE

**N93-19030** Connecticut Univ., Storrs.
**A POSTULATIONAL FORMULATION OF MAGNETOHYDRODYNAMICS Ph.D. Thesis**
Gerard Coutu 1992 90 p
Avail: Univ. Microfilms Order No. DA9300927

A postulational formulation of magnetohydrodynamics is derived. In particular, two competing postulates are shown to result in two different electrodynamic forces between moving charged particles. The first force term is based on the usual assumptions of absolute velocity and, hence, is called the classical force. The second formulation contends that the force depends on the relative motion of the two charged particles and is called the relative velocity formulation. Three physical problems were examined for the predicted behavior of the two different force terms. The first problem is the well known pinch effect. Both formulations result in an identical predicted force. The second problem is the Hering Furnace. In this example, the predicted forces are not the same. Only the force predicted by the relative velocity formulation adequately describes the experiment. The last problem is the weld problem. Again, the relative velocity formulation is the only adequate choice to match the experiment. Dissert. Abstr.

**N93-19385** Iowa Univ., Iowa City.
**MAGNETOHYDRODYNAMIC WAVE-ASSOCIATED PLASMA DENSITY FLUCTUATIONS IN THE EARTH'S FORESHOCK REGION Ph.D. Thesis**
James Arlan Leckband 1992 292 p
Avail: Univ. Microfilms Order No. DA9235865

Twenty episodes of magnetohydrodynamic wave activity in the Earth's ion foreshock region have been analyzed. Fluctuations in the electron density and magnetic field were analyzed to identify the various linear and nonlinear plasma processes that may be occurring in this region. Correlations between the density and various magnetic field components were performed. One major finding is that the component of the magnetic field parallel to the mean field is strongly correlated with the density fluctuations over a wide variety of scales. In addition two distinct wave populations were seen to exist. These findings have been interpreted as being the result of nonlinear parametric instabilities acting on obliquely propagating MHD waves. Dissert. Abstr.

**N93-19618#** General Atomic Co., San Diego, CA.
**REGIMES OF IMPROVED CONFINEMENT AND STABILITY IN D3-D OBTAINED THROUGH CURRENT PROFILE MODIFICATIONS**
L. L. Lao, J. R. Ferron, T. S. Taylor, V. S. Chan, T. H. Osborne, K. H. Burrell, M. S. Chu, J. C. DeBoo, C. M. Greenfield, and R. J. Groebner et al Sep. 1992 10 p Presented at the 14th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Wuerzburg, Germany, 30 Sep. - 7 Oct. 1992
(Contracts DE-AC03-89ER-51114; DE-AC05-84OR-21400; W-7405-eng-48)
(DE93-002674; GA-A-21053; CONF-920913-21) Avail: CASI HC A02/MF A01

Several regimes of improved confinement and stability have been obtained in recent experiments in the DIII-D tokamak by dynamically varying the toroidal current density profile to transiently produce a poloidal magnetic field profile with more favorable confinement and stability properties. A very peaked current density profile with high plasma internal inductance, l(sub i), is produced either by a rapid change in the plasma poloidal cross section or by a rapid change in the total plasma current. Values of thermal energy confinement times nearly 1.8 times the JET/DIII-D ELM-free H-mode thermal confinement scaling are obtained. The confinement enhancement factor over the ITER89-P L-mode confinement scaling, H, is as high as 3. Normalized toroidal beta, beta(sub N), greater than 6 percent-m-T/MA and values of the product (beta(sub N))H greater than 15 were also obtained. Both the confinement and the maximum achievable beta vary with l(sub i) and decrease as the current profile relaxes. For strongly shaped H-mode discharges, in addition to the current density profile peakedness, as measured by l(sub i) other current profile parameters, such as its distribution near the edge region, may also affect the confinement enhancement. DOE

**N93-19619#** General Atomic Co., San Diego, CA.
**ADVANCED DIVERTOR PROGRAM RESULTS FROM D3-D**
M. J. Schaffer, N. H. Brooks, T. E. Evans, R. J. Groebner, F. L. Hinton, M. A. Hollerbach, A. W. Hyatt, G. L. Jackson, A. W. Leonard, and S. I. Lippmann et al Sep. 1992 8 p Presented at the 14th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Wuerzburg, Germany, 30 Sep. - 7 Oct. 1992
(Contracts DE-AC03-89ER-51114; W-7405-eng-48; DE-AC03-89ER-53277; DE-AC05-84OR-21400; DE-FG03-89ER-51121)
(DE93-002675; GA-A-21044; CONF-920913-20; IAEA-CN-56/A-5-2) Avail: CASI HC A02/MF A01

A summary of DIII-D boundary and diverter experiments directed at solving the scientific and technical problems of high power, long-pulse tokamak diverters is presented. Single-null poloidal diverters were studied in the standard DIII-D open diverter configuration and in interaction with the toroidally symmetric ring biasing electrode and exhaust gas collection plenum. New results are reported for: scrape-off layer (SOL) transport; SOL density and unpurity influx; SOL density and diverter bias; Edge Localized Mode (ELM) particle and energy content; ELMing SOL transport; open radiative diverter; passive exhaust gas collection; diverter bias and exhaust gas collection; and diverter bias and H-mode threshold. Future plans for diverter research at DIII-D are included. DOE

**N93-19743#** Oak Ridge National Lab., TN.
**SELF-REGULATED SHEAR FLOW TURBULENCE IN CONFINED PLASMAS: BASIC CONCEPTS AND POTENTIAL APPLICATIONS TO THE L YIELDS H TRANSITION**
P. H. Diamond (California Univ., San Diego.), V. Shapiro (California Univ., San Diego.), V. Schevchenko (California Univ., San Diego.), Y. B. Kim (California Univ., San Diego.), M. N. Rosenbluth (California Univ., San Diego.), B. A. Carreras, K. Sidikman, V. E. Lynch, and L. Garcia 1992 48 p Presented at the 14th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Wuerzburg, Germany, 30 Sep. - 7 Oct. 1992
(Contract DE-AC05-84OR-21400)
(DE93-002361; CONF-920913-19; IAEA-CN-56/D-2-4) Avail: CASI HC A03/MF A01

This paper describes developments in the theory of edge plasma turbulence in a differentially rotating plasma. The thesis that such systems are dynamically self-regulating is presented. Results indicate that relevant fluctuations will generate a predominantly curved flow. Similarly, curvature is shown to be the predominant flow profile effect on fluctuations. A system fixed point is identified, the eigenfrequencies for small oscillations around it are calculated, and an over-all stability criterion is determined. DOE

**N93-19754#** General Atomic Co., San Diego, CA.
**THE CQL3D FOKKER-PLANCK CODE**
R. W. Harvey and M. G. McCoy (Lawrence Livermore National Lab., CA.) Nov. 1992 38 p Presented at the International Atomic Energy Agency (IAEA) Technical Committee Meeting on Advances in Simulation and Modeling of Thermonuclear Plasmas, Montreal, Quebec, 15 Jun. 1992
(Contracts DE-AC03-89ER-53277; W-7405-eng-48)
(DE93-002962; GA-A-20978; CONF-9206235-3) Avail: CASI HC A03/MF A01

CQL3D is a general purpose computer code for modeling auxiliary heating in tokamaks. It calculates the radial distribution of 2D in momentum-space bounce-averaged, ion and electron distribution functions in toroidal geometry, consistent with deposition of rf and/or neutral beam injected power and a diffusive radial transport model. This calculation is carried out with an array of bounce-averaged Fokker-Planck (FP) solvers running on noncircular magnetic flux surfaces, giving the steady-state, toroidally-averaged distribution resulting from a balance between collisions, dc electric field, rf quasilinear diffusion, synchrotron radiation, neutral beam injection, and radial diffusion. CQL3D is coupled to ray-tracing codes for electron cyclotron, lower hybrid, and fast waves, to a neutral beam deposition code, and to a noncircular equilibrium code. We describe the code, providing expressions and methodology for calculation of the FP coefficients from each of the constituent processes, and give benchmark applications in order to validate the major components of the code. DOE

**N93-19793#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**REPORT OF ACTIVITIES IN THE GAS AND PLASMA PHYSICS LABORATORY (LPGP) OF THE PARIS-SOUTH UNIVERSITY, APRIL - MAY 1991 [RELATORIO DE ATIVIDADES NO LABORATOIRE DE PHYSIQUE DU GAZ ET DES PLASMAS (LPGP) DA UNIVERSITE DE PARIS-SUD, ABRIL - MAIO 1991]**
Jose Leonardo Ferreira 1991 17 p In PORTUGESE
(INPE-5349-PRP/162) Avail: CASI HC A03/MF A01

This report describes the activities in a project to study waves and turbulence in plasmas which are being conducted by the French LAP and the LPGP. Studies aimed at studying resonant absorption of electromagnetic waves in quiescent plasma with a controlled density gradient were conducted in April and May. These studies are serving as a basis for assembling an experiment on generation of nonlinear Langmuir waves through collision of two electromagnetic waves of different frequencies. Also conducted during this period, in agencies of the LAP, were studies on the viability of constructing a magnetized quiescent plasma machine for whistler wave research. The plasma wave and turbulence studies program in France was concluded with a visit to the space plasma experiments in progress at the Centre D'Etude Spatiale des Reyonnements, located in the Complex Scientifique de Rangueil in Toulouse. Transl. by FLS

**N93-19829#** Lawrence Livermore National Lab., CA.
**MULTI-FLUID MODELING OF INTERPENETRATING PLASMAS**
P. W. Rambo and J. Denavit Sep. 1992 20 p Presented at the 1992 CECAM Workshop, Orsay, France, 7-11 Sep. 1992
(Contract W-7405-eng-48)
(DE93-002893; UCRL-JC-111893; CONF-9209268-1) Avail: CASI HC A03/MF A01

One dimensional multi-fluid simulations of interpenetrating plasmas are presented. Separate fluid equations for multiple species are solved with coupling between the different species due to the electric field and Coulomb collisions. These simulations show initial interpenetration followed by stagnation. We present scaling results for colliding plasmas characteristic of opposing, laser heated discs. Simulations of colliding CH plasmas with separate ion fluids for the Carbon and Hydrogen are presented showing appreciable atomic separation. We also show results from hybrid particle and fluid simulations, where particles are used in addition to fluids to represent physical species. DOE

**N93-19836#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**SUGGESTIONS FOR THE MAGNETIC DIAGNOSTIC FIXING SYSTEM IN THE INSIDE OF TOKAMAK TBR-E [SUGESTOES PARA O SISTEMA DE FIXACAO DE DIAGNOSTICOS MAGNETICOS NO INTERIOR DO TOKAMAK TBR-E]**
Jose Leonardo Ferreira Jun. 1991 8 p In PORTUGESE
(INPE-5277-NTC/298) Avail: CASI HC A02/MF A01

In small tokamaks, access of magnetic coils to the space between the vacuum vessel and the ohmic heating transformer is limited by the lack of room. The best answer for magnetic diagnostic devices which need to have a polar orientation is to put them in the toroidal vacuum chamber. The big advantage of putting magnetic coils and probes inside the vessel is reduction of magnetic signal delay and attenuation. At the same time, some technical problems arise, such as the need to encapsulate and cool the probes and coils, which are generally made of material which is quite volatile in a high vacuum environment. There is also the problem of protecting these structures from the intense plasma current, which in the TBR-E must go as high as 240 kA. The coils must, therefore, be protected at all times by the shade of the on-board plasma limiter. Two design suggestions for the system of fixing the tubes which contain the coils are presented. All retaining pins or screws should be of 304 or 316 L stainless steel (unmagnetizable). The pins can be welded to the inside of the vacuum vessel before its various parts are assembled. It is important to note that the 16 fixer lines must be welded in a manner so as to coincide with the positions of the 16 toroidal coils. The placement of the protection plates and screws can be made later, through the vacuum ports. Author

**N93-19883#** National Inst. for Fusion Science, Nagoya (Japan).
**A KINETIC SIMULATION OF LOW-FREQUENCY ELECTROMAGNETIC PHENOMENA IN INHOMOGENEOUS PLASMAS OF THREE-DIMENSIONS**
Motohiko Tanaka Nov. 1992 65 p Submitted for publication
(NIFS-199) Avail: CASI HC A04/MF A01

An advanced implicit particle simulation method was developed and implemented in the HIDENEK code to study large space-scale, low-frequency electromagnetic phenomena occurring in inhomogeneous plasmas. The present method is specially designed for high magnetic field (omega(sub ce) is greater than or equal to omega(sub pe)), inhomogeneous plasma simulations. The guiding-center approximation with magnetic drifts is adopted to the perpendicular motion of the electrons whereas the inertia effect is retained in their parallel motion. Also, a slightly backward time-decentered scheme is introduced to the equations of motion and the Maxwell equations. These equations are combined to yield the full-implicit, coupled field-particle equations which allow us to determine the future electromagnetic field in a large time step compared to the electron time scales with the diamagnetic drift and magnetization currents being included. Three physics applications are shown as a demonstration in terms of the electromagnetic beam-plasma instability, the temperature anisotropy-driven Alfven-ion-cyclotron instability, and the external kink instability of the peaked-density current beam. A remarkable pitch-angle scattering of the ions is observed in the first two applications in association with the plasma instabilities. In the third application to an inhomogeneous, finite-beta plasma of the three-dimensions, a helical deformation is shown to take place to the initially straight beam and magnetic axis in an ideal magnetohydrodynamic time scale. Author

**N93-19884#** National Inst. for Fusion Science, Nagoya (Japan).
**ROLES OF ELECTRIC FIELD ON TOROIDAL MAGNETIC CONFINEMENT**
Kimitaka Itoh, Sanae-I. Itoh (Kyushu Univ., Fukuoka, Japan ), Heiji Sanuki, and Atsushi Fukuyama (Okayama Univ., Japan ) Nov. 1992 50 p Sponsored in part by the Scientific Research of the Ministry of Education of Japan
(NIFS-200) Avail: CASI HC A03/MF A01

Theoretical research on the influence of the electric field on the toroidal magnetic confinement is surveyed. The static electric field is first described. Physics pictures on the generation of the radial electric field and the influence on the confinement are shown. Neoclassical effects as well as the nonclassical processes are discussed. Emphasis is made on the connection with the improved confinement. Convective cell, i.e., the nonuniform potential on the magnetic surface, is also discussed. The roles of the fluctuating electric field are then reviewed. The progress in the recent theories on the anomalous transport is addressed. Through these surveys, the impact of the experiments using the heavy ion beam probes on the modern plasma physics is illustrated. Author

**N93-19885#** National Inst. for Fusion Science, Nagoya (Japan).
**HAMILTONIAN FOR THE TOROIDAL HELICAL MAGNETIC FIELD LINES IN THE VACUUM**
G. Gnudi (Hiroshima Univ., Japan ) and T. Hatori Nov. 1992 20 p Sponsored in part by the Japanese Ministry of Education
(NIFS-201) Avail: CASI HC A03/MF A01

The toroidal helical magnetic field possesses magnetic surfaces in the proximity of the magnetic axis, while in regions far from the magnetic axis such surfaces to not exist. The domain in which magnetic surfaces do not exist is called magnetic chaos domain, and between the magnetic axis and the magnetic chaos domain lies the outermost surface, whose position is an important information from the point of view of magnetic confinement. Since the divergence of the magnetic field is zero, the magnetic field lines system can be treated as a hamiltonian system. For hamiltonian systems the phase space structure is subdivided into chaotic and non-chaotic regions, and this subdivision has a correspondence with the magnetic chaos domain and the magnetic surfaces domain discussed above. In order to further advance this research it is necessary to approach the problem form the point of view of hamiltonian theory, in which the divergence-free property is rigorously respected. Besides, for hamiltonian systems it is possible to use symplectic integration techniques to solve the equation of motion, techniques which are free from secular, or dissipative errors. This fact make the application of symplectic techniques very attractive. The research approaching the toroidal helical magnetic field problem from the hamiltonian point of view ends with works done more than ten years ago, partly because of the strong push towards research on tokamaks. However, two good reasons to revive the hamiltonian approach to the toroidal helical magnetic field problem are: (1) the Japanese Ministry of Education is pushing the research concerning the helical systems approach to magnetic confinement; and (2) the last ten years have seen an impetuous development of chaos physics, and times are ripe for research about the chaotic properties of the toroidal helical magnetic field lines system. An explicit form for the Boozer's magnetic coordinates in the first order toroidal correction to the cylindrical helical magnetic configuration was obtained using the lie perturbation expansion technique to proceed to higher orders. Author

**N93-19896#** General Atomic Co., San Diego, CA.
**PROFILE CHARACTERISTICS OF H-MODE BIFURCATION MODELS AND TURBULENCE SIMULATIONS WITH GYRO-LANDAU FLUID MODELS IN SLAB AND TOROIDAL GEOMETRY**
G. M. Staebler, R. E. Waltz, R. R. Dominguez, C. M. Greenfield, F. L. Hinton, M. Beer (Princeton Univ., NJ.), W. Dorland (Princeton Univ., NJ.), G. W. Hammett (Princeton Univ., NJ.), and G. D. Kerbel Sep. 1992 8 p Presented at the 14th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Wuerzburg, Germany, 30 Sep. - 7 Oct. 1992
(Contracts DE-AC03-89ER-51114; DE-AC03-89ER-53277; W-7405-eng-48; DE-AC02-76CH-03073)
(DE93-002676; GA-A-21055; CONF-920913-22; IAEA-CN-56/D-4-17)
Avail: CASI HC A02/MF A01

A study of the sensitivity of the width of the H-mode transport barrier on the energy, particle and momentum sources has led to a possible explanation for the very high confinement (VH-mode) presented in Part A of this paper. In Part B recent progress in the development of Gyro-Landau Fluid (GLF) models n described. GLF models with a few moment equations encompass with high accuracy both linearly and nonlinearly the effects of finite gyroradius to all orders and of the Landau resonances in both parallel field and curvature drift motion. Numerical simulation of turbulence with a novel application of a nonlinear ballooning mode representation of these models is given. DOE

**N93-19897#** General Atomic Co., San Diego, CA.
**STABILITY OF TAE MODES IN DIII-D**
E. J. Strait, M. S. Chu, L. L. Lao, A. D. Turnbull, W. W. Heidbrink (California Univ., Davis.), and H. H. Duong (California Univ., Davis.) Sep. 1992 8 p Presented at the 14th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Wuerzburg, Germany, 30 Sep. - 7 Oct. 1992
(Contracts DE-AC03-89ER-51114; DE-FG03-89ER-51121)
(DE93-002677; GA-A-21045; CONF-920913-23) Avail: CASI HC A02/MF A01

TAE modes driven by neutral beam injection have been observed in DIII-D. The measured frequency agrees very well with theoretical predictions for DIII-D discharges. At large amplitude these instabilities can lead to loss of over 50 percent of the beam power, as well as large loss of non-resonant MeV fusion products. The threshold value of fast ion beta for destabilization and the observed range of unstable mode numbers are in reasonable agreement with predictions for the mode growth rate. Continuum damping dominates at low mode numbers, while damping by electron kinetic effects dominates at high mode numbers. Preliminary experiments suggest that TAB modes can be stabilized by current profile control. DOE

**N93-19931#** National Inst. for Fusion Science, Nagoya (Japan).
**MESH EFFECT IN A PARALLEL PLATE ANALYZER**
Y. Hamada, Y. Kawasumi, H. Iguchi, A. Fujisawa, Y. Abe (Iwate Univ., Morioka, Japan ), and M. Takahashi (Iwate Univ., Morioka, Japan ) Dec. 1992 32 p
(NIFS-203) Avail: CASI HC A03/MF A01

The effect of field irregularity due to meshes on the holes of a lower electrode in a parallel-plate electrostatic analyzer for beam penetration, is experimentally and numerically investigated. Displacement of a focal point and degradation of analyzer characteristics are found in the experiment. They are also confirmed by numerical analysis. Criteria for the error estimation are theoretically derived and found to be consistent with the experiment. Author

**N93-19933#** National Inst. for Fusion Science, Nagoya (Japan).
**ON THE LAGRANGIAN OF THE LINEARIZED MHD EQUATIONS**
Jiro Todoroki Jun. 1992 11 p
(NIFS-154) Avail: CASI HC A03/MF A01

Lagrangian for the linearized, ideal and resistive, magnetohydrodynamics (MHD) equations is discussed by introducing the perturbation of the total pressure. In the resistive MHD equations, the Lagrangian is expressed in terms of the electric displacement vector (time integral of the electric current) as well as the plasma displacement. The NOVA and NOVA-R formulation can be derived by using the obtained Lagrangian. Author

**N93-19942#** National Inst. for Fusion Science, Nagoya (Japan).
**PHYSICS OF TRANSPORT PHENOMENA IN MAGNETIC CONFINEMENT PLASMAS**
Kimitaka Itoh, Sanae-I. Itoh (Kyushu Univ., Fukuoka, Japan ), and Atsushi Fukayama (Okayama Univ., Japan ) Dec. 1992 36 p Submitted for publication
(NIFS-202) Avail: CASI HC A03/MF A01

The phenomena caused by the transport of the plasma across the magnetic field in toroidal devices are surveyed, and theoretical models are reviewed. The plasma structure in a steady state is discussed. The recent development of the theory on the plasma transport driven by the microscopic turbulence is explained. The sudden change in confinement, such as the H-mode transition in tokamaks, is discussed next. The physics of the bifurcation of the edge plasma, based on the dynamics of the radial electric field, is discussed. Finally, the role of the anamolous transport on the disruptive phenomena is reviewed. Author

**N93-19945*#** Alabama Univ., Huntsville. Dept. of Electrical and Computer Engineering.
**A NEW APPROACH TO PLASMASPHERE REFILLING: ANOMALOUS PLASMA EFFECTS Semiannual Progress Report, 1 Nov. 1990 - 30 Apr. 1991**
N. Singh 1991 19 p
(Grant NAGw-2128)
(NASA-CR-192128; NAS 1.26:192128) Avail: CASI HC A03/MF A01

During the last 10 months of the grant, both laminar and anomalous plasma processes occurring during the refilling of the outer plasmasphere after magnetic storms are investigated. Theoretical investigations were based on two types of models: (1) two-stream hydrodynamic model in which plasma flows from the conjugate ionospheres are treated as separate fluids and the ion temperature anisotropies are treated self-consistently; and (2) large-scale particle-in-cell code. Author

**N93-19951#** National Inst. for Fusion Science, Nagoya (Japan).
**CRITICAL ISSUES AND EXPERIMENTAL EXAMINATION ON SAWTOOTH AND DISRUPTION PHYSICS**
Kimitaka Itoh, Sanae-I. Itoh, Atsushi Fukuyama (Okayama Univ., Japan ), and S. Tsuji (Japan Atomic Energy Research Inst., Ibaraki.) Jun. 1992 33 p Sponsored by JAERI and the Japanese Ministry of Education
(NIFS-157) Avail: CASI HC A03/MF A01

The catastrophic phenomena which are associated with disruption and sawtooth physics contain three key processes: (1) sudden acceleration of the growth of the helical deformation; (2) central electron temperature crash; and (3) rearrangement of the plasma current. Based on the theoretical model that the magnetic stochasticity plays a key role in these processes, the critical issues and possible experimental tests are proposed. Present experimental observations would be sufficient to study the detailed sequences and causes. Though the models may not be complete, comparison with experimental findings improves our understanding.
Author (revised)

**N93-19584#** Grassmann (Volker), Wuppertal (Germany).
**THE EFFECT OF DIFFERENT COLLISION OPERATORS ON THE STANDARD DATA ANALYSIS MODEL Abstract Only**
Volker Grassmann *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

# 76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**N93-17864#** Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ.
**THE CRYSTAL AND MOLECULAR STRUCTURE OF TRIETHANOL-AMMONIUM NITRATE**
A. J. Bracuti Dec. 1992 29 p
(AD-A258428; ARAED-TR-92026) Avail: CASI HC A03/MF A01

The liquid propellant used in the 155-mm regenerative liquid propellant gun is XM46. XM46 is a solution of 60 percent hydroxyl ammonium nitrate (HAN), 20 percent triethanolammonium nitrate (TEAN), and 20 percent water. This material exhibits rather unusual liquid properties that have been attributed to its being a 'molten eutectic' of fused salts rather than a normal aqueous solution of two different nitrate salts. A hydrogen-bonded liquid structure for eutectic LP1946 was proposed previously based on the known structures of neat HAN and water and a best-guess estimate of the TEAN structure. To verify this estimate, the molecular structure of neat TEAN was recently determined. This investigation revealed TEAN has very unusual and interesting bifurcated intermolecular and trifurcated intramolecular hydrogen bonding configurations within the crystal. If these hydrogen bonding configurations are retained in aqueous solution, they could be responsible in some part to the observed unusual liquid properties of liquid propellant XM46. GRA

**N93-17923#** Army Materials Technology Lab., Watertown, MA.
**THE PRE-ONSET, TRANSITIONAL, AND FOOT REGIONS IN RESISTANCE VERSUS TEMPERATURE BEHAVIOR IN HIGH-T2 CUPRATES: INFERENCES REGARDING MAXIMUM T2 Final Report**
G. C. Vezzoli, T. Burke, M. F. Chen, F. Craver, and W. Stanley Sep. 1992 25 p
(AD-A258175; MTL-TR-92-67) Avail: CASI HC A03/MF A01

We have studied the pre-onset deviation-from-linearity region, the transitional regime, and the foot region in the resistance versus temperature behavior of high-T sub c oxide superconductors, employing time varying magnetic fields and carefully controlled precise temperatures. We have shown that the best value of T sub c can be extrapolated from the magnetic field induced divergence of the resistance versus inverse absolute temperature data as derived from the transitional and/or foot regions. These data are in accord with results from previous Hall effect studies. The pre-onset region however, shows a differing behavior (in R versus 1000/T as a function of B) which we believe links it to an incipient Cooper pairing that suffers a kinetic barrier opposing formation of a full supercurrent. This kinetic dependence is believed to be associated with the lifetime of the mediator particle. This particle is interpreted to be the virtual exciton formed from internal-field induced charge-transfer excitations which transiently neutralize the multivalence cations and establish bound holes on the oxygens. GRA

**N93-17935#** Rome Univ. (Italy). Dipt. di Fisica.
**GROWTH AND CHARACTERIZATION OF SINGLE CRYSTALS**
C. Sanipoli and A. Scacco 31 Jul. 1991 34 p
(Nota-Interna-984; ETN-93-93348) Avail: CASI HC A03/MF A01

A review of the experimental methods for growing single crystals and the techniques used for their characterization is presented. The crystal growth facility, operating at the La Sapienza University in Rome, Italy, is described in detail, and the scientific applications of the grown materials in several institutions and in various countries are reported. In particular the following are addressed: thermodynamics of the growth process and crystal habit; solid growth and melt growth techniques; solution growth methods and vapor phase growth; Czochralski and Bridgman equipment; and crystal scientific utilization. ESA

**N93-18005#** Carnegie-Mellon Univ., Pittsburgh, PA.
**HIGH RESISTIVITY GaAs EPILAYERS BY OXYGEN DOPING Annual Report, 1 Sep. 1991 - 31 Aug. 1992**
Marek Skowronski 30 Sep. 1992 14 p
(Grant AF-AFOSR-0373-91)
(AD-A257931; Rept-152171) Avail: CASI HC A03/MF A01

During the first year of research our OMVPE system has been retrofitted with a charcoal exhaust scrubber, toxic gas detector, and process gas delivery system. All components have been fully tested and calibrated for GaAs deposition. High quality undoped GaAs epilayers have been deposited with following characteristics: specular morphology, low free carrier concentration (p = 1(10)(exp 15) cm(exp -3)) and high mobility (4,000sq cm/Vs at 77K). The dominant acceptor is carbon originating from gallium source as determined by the high resolution photoluminescence. Doping of GaAs epilayers with dimethylaluminum methoxide resulted in incorporation of both oxygen and aluminum in concentrations up to 5(10)(exp 18) cm(exp -3) and 7(10)(exp 19) cm(exp -3), respectively. Oxygen concentration increases rapidly with decreasing deposition temperature. Heavily oxygen doped layers (obtained either by high DMAlMO flow or growth at temperatures below 600 C) are highly resistive and exhibit extremely low carrier lifetime. Photoluminescence measurements detected new luminescence bands in 850 - 1000 nm range which are assigned to deep oxygen induced traps. GRA

**N93-18079#** Research Triangle Inst., Research Triangle Park, NC.
**HETEROEPITAXIAL DIAMOND GROWTH Quarterly Report, 16 Apr. - 30 Jun. 1992**
R. J. Markunas, R. A. Rudder, J. B. Posthill, R. E. Thomas, and G. Hudson 1 Nov. 1992 97 p
(Contract N00014-92-C-0081)
(AD-A257510; RTI-83U-5294) Avail: CASI HC A05/MF A02

Work at Research Triangle Institute during this quarter concentrated on establishing directions and meaningful collaborations through which progress towards large-area, single-crystal diamond could be obtained. Three formal subcontracts on the RTI prime have been established to pursue ab initio diamond surface kinetics, ion implantation studies, and atomic scale characterization of diamond respectively. The program here at RTI has adopted two approaches to pursue large-area, single crystal diamond: (1) heteroepitaxial diamond growth, and (2) diamond bonding, consolidation, and lift-off. These two approaches have dictated the experimented directions for the program. GRA

**N93-18092#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
**INFRARED-INDUCED PHOTOCONDUCTIVITY AND ELECTROLUMINESCENCE IN FORWARD-BIASED a-Si:H PIN-DIODES**
Joerg Wind (Technische Univ., Munich, Germany ) and Gerhard Mueller 1991 5 p Repr. from Journal of Non-Crystalline Solids, v. 137-138, 1991 p 1267-1270 Presented at 14th ICAS, Garmisch-Partenkirchen, Germany, 19-23 Aug. 1991
(MBB-Z-0376-91-PUB; ETN-92-92750) Avail: CASI HC A01/MF A01

The electronic properties of amorphous (a-)Si:H pin diodes were investigated under conditions of forward bias and low temperature operations. The experiments demonstrate that, under these conditions, a-Si:H pin diodes can respond to infrared (IR) radiation through an enhancement in the diode currents and, through an enhancement in the electroluminescence signal. It is proposed that the IR photoeffect is due to the reexcitation of band tail trapped excess carriers injected into the localized conduction and valence band tail states in the vicinity of the n(+) and p(+) contact regions. ESA

**N93-18117#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
**WRITING ELECTRONICALLY ACTIVE NANOMETER-SCALE STRUCTURES WITH A SCANNING TUNNELING MICROSCOPE**
E. Hartmann (Technische Univ., Munich, Germany ), R. J. Behm (Technische Univ., Munich, Germany ), Gerhard Kroetz, Gerhard Mueller, and F. Koch (Technische Univ., Munich, Germany ) 1991 4 p Repr. from Appl. Phys. Lett., v. 59, no. 17, 21 Oct, 1991 p 2136-2138 Previously announced in IAA as A92-10368 Sponsored in part by Siemens A.G.
(MBB-Z-0367-91-PUB; ETN-92-92747) Avail: CASI HC A01/MF A01

The feasibility of producing electronically active nanometer scale structures in thin amorphous Si:H films up to 100 nm thickness by use of a Scanning Tunneling Microscope (STM) (writing cycle) was demonstrated. These structures arise from a modification of the local structural arrangement of dopant and Si atoms, induced by tunnel voltage and tunnel current. Owing to the different electronic nature, they are detected as apparent protrusions in STM images (reading cycle). ESA

**N93-18118#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
**CRYSTALLINE-AMORPHOUS CONTRAST FORMATION IN THERMALLY CRYSTALLIZED SiC**
B. Ruttensperger (Technische Univ., Munich, Germany ), G. Kroetz, Gerhard Mueller, G. Derst (Max-Planck-Inst. fuer Kernphysik, Heidelberg, Germany), and S. Kalbitzer (Max-Planck-Inst. fuer Kernphysik, Heidelberg, Germany), 1991 5 p Repr. from Journal of Non-Crystalline Solids, v. 137-138, 1991 p 635-638 Presented at 14th ICAS, Garmisch-Partenkirchen, Germany, 19-23 Aug. 1991
(Grant EEC-3404/BRITE/EURAM)
(MBB-Z-0373-91-PUB; ETN-92-92749) Avail: CASI HC A01/MF A01

The crystallization of stochiometric amorphous SiC:H films, deposited onto crystalline Si and highly transparent sapphire substrates, was investigated. After annealing, transparent polycrystalline material is obtained due to an emerging indirect band gap. Irradiation of the crystallized films with energetic Ar(+) ions transforms the films into a heavily absorbing amorphous state. Possible applications of this effect with regard to submicron lithography and to high density optical storage are discussed. ESA

**N93-18125#** SRI International Corp., Menlo Park, CA.
**PROCESSING AND FABRICATION OF HIGH TEMPERATURE OXIDE SUPERCONDUCTORS Final Report, 1 Sep. 1988 - 30 Oct. 1992**
Sylvia M. Johnson and Michael I. Gusman 30 Nov. 1992 130 p
(DARPA Order 9525)
(AD-A258281) Avail: CASI HC A07/MF A02

Synthesis of YBa2Cu3O7-a superconductor powders by freeze-drying was developed. The freeze-drying process consists of forming a solution of Y and Cu nitrates and Ba acetate, freezing, sublimating the water and calcination. The effect of processing variables on the powder characteristics, including surface area, size, stoichiometry, agglomeration, were investigated. Stoichiometry control requires control of the chemistry of the system, and careful analysis of starting solutions is required to prepare powders of the desired composition. Powders were sintered into pellets and the superconducting behavior was evaluated. Stanford University served as a subcontractor and was responsible for most of the critical transition temperature and critical current measurements. GRA

**N93-18172#** Hughes Research Labs., Malibu, CA.
**SUPERLATTICES FOR INFRARED DETECTORS Final Report, Sep. 1989 - Oct. 1992**
R. H. Miles 30 Oct. 1992 100 p
(Contract N00014-89-C-0203)
(AD-A257511; HAC-REF-G8869) Avail: CASI HC A05/MF A02

GaInSb/InAs superlattices have been grown and analyzed for use as high performance, high operating temperature 8 to 12 micron infrared detectors. Optical and transport properties favorable for long wavelength IR detection have been measured, and preliminary photoconductive and photovoltaic device structures have been fabricated and tested. Our results underscore the considerable potential of GaInSb/InAs superlattices to achieve detectivities comparable to HgCdTe at considerably higher operating temperatures. Such an improvement would be of significant benefit, both in reduced cost and complexity, to high performance DoD IR sensing systems. Molecular beam epitaxial (MBE) growth techniques were developed, yielding superlattices of exceptionally high structural quality, with uncompensated background doping in the low-to-mid 10(exp 15) cm(exp -3) range, n-type. Methods for silicon doping the superlattices were established, allowing n-on-p and p-on-n photojunctions to be grown. Superlattice energy gaps were shown to span the infrared, and a 10-micron absorption coefficient comparable to that of HgCdTe was measured, in agreement with theory. Initial unpassivated photovoltaic test devices show R(0)A = 0.1 Omega-cm(exp 2) at 77 K, for a 12-micron cutoff. GRA

**N93-18238#** Florida Univ., Gainesville. Dept. of Electrical Engineering.
**DEVELOPMENT OF ULTRA-LOW NOISE, HIGH SENSITIVITY PLANAR METAL GRATING COUPLED AlGaAs MULTIQUANTUM WELL IR DETECTORS FOR FOCAL PLANE ARRAY STARING IR SENSOR SYSTEMS Quarterly Report No. 5, 1 Aug. - 31 Oct. 1992**
Sheng S. Li 10 Nov. 1992 57 p
(Contract N00014-91-J-1976)
(AD-A257799) Avail: CASI HC A04/MF A01

The project objectives are the following: to develop ultra-low dark current and high detectivity planar metal grating coupled bound-to-miniband (BTM)

3-5 quantum well infrared photodetectors (QWIP's) for 8 to 12 microns focalplane array (FPA) staring IR sensor system; to develop novel type-1 and type-2 3-5 QWIP's with multicolor, broad, and narrow band spectral response in the 8 to 14 microns wavelength range (the material systems to be studied include GaAs/AlGaAs, AlAs/AlGaAs, and InGaP/GaAs substrates, and InAlAs/InGaAs grown on InP substrate); to conduct theoretical and experimental studies of the planar metal grating-coupled structures for normal incident illumination on the QWIP's (different metal grating coupling structures using 1-D (line) and 2-D (square) metal gratings for the QWIP's will be studied in order to achieve high coupling efficiency under normal front- and back illuminations); and to perform theoretical and experimental studies of dark-current, photocurrent, optical absorption, spectral responsivity, noise, and detectivity on different types of QWIP's developed under this program. GRA

**N93-18310#** Wales Univ. Inst. of Science and Technology, Cardiff.
**THE FOURTH CONFERENCE ON ORGANIZED THIN FILMS**
12 Sep. 1992 201 p Conference held in Bangor, Wales, 10-12 Sep. 1992
(Contract DAJA-45-92-M-0160)
(AD-A258315; R/D-6895-CH-02) Avail: CASI HC A10/MF A03

Abstracts of papers presented at the Fourth European Conference on Organized Thin Films are included. Topics covered include: structure of monolayers and LB films; supermolecular structures; molecular electronics; non-linear optical properties; optical properties and characterization; and molecular recognition. L.R.R.

**N93-18311#** Naval Research Lab., Washington, DC.
**THEORY OF ARTIFACT DIAMOND Interim Report, Oct. 1991 - Sep. 1992**
W. E. Pickett and M. R. Pederson 4 Nov. 1992 13 p
(AD-A258474) Avail: CASI HC A03/MF A01

Our goal is to develop an understanding of how nucleation of diamond growth can be beneficially enhanced. Our research has concentrated on how different types of surface passivator might positively impact diamond nucleation and growth. We have focused these studies on the fluorinated and hydrogenated (100) surfaces, which have some chemical similarities (and some differences) but have considerably different sizes. We have initiated work on boron-doped and beryllium-doped diamond (100) surfaces with a view towards alternative passivation of the diamond surface. The idea was to investigate how atoms other than carbon could maintain an unreconstructed diamond (100) surface, but lead to better growth and nucleation rates. The working assumption is that better growth rates will be obtained if passivators prevent surface reconstruction but promote the adsorption of carbon in four-fold configurations. GRA

**N93-18313#** David Sarnoff Research Center, Princeton, NJ.
**HIGH PERFORMANCE YBCO FILMS Report, 1 Aug. - 31 Oct. 1992**
Edgar J. Denlinger, Aly Fathy, David Kalokitis, and Valerie Pendrick 31 Oct. 1992 32 p
(Contract N00014-91-C-0216; DARPA Order 8100)
(AD-A258481) Avail: CASI HC A03/MF A01

The objective of this program is to identify suitable low loss, low dielectric constant substrates and develop and optimize deposition processes for high quality YBCO films including the necessary buffer layers. Ultimate goals are large area substrates having double-sided HTS coating with a surface resistance ten times lower than copper at 40 GHz. High quality HTS films on low dielectric constant substrates are expected to find widespread use in advanced millimeter wave components, in extending the power handling capability of microwave and millimeter wave circuitry, and in facilitating high speed computer interconnects. Sample demonstration circuits will be built toward the end of the program. We have successfully deposited a high quality YBCO film on a good low loss and low dielectric constant substrate, magnesium fluoride (epsilon approximately 5). With the use of two buffer layers (magnesium oxide and strontium titanate) between the YBCO and the substrate, transition temperatures of 89 K and transition widths of about 0.5 K were achieved. The critical current density J(sub c) of 4(10)(exp 6) A/sq cm at 77 K in zero field is among the highest reported for YBCO films. The magnesium fluoride (MgF2) substrate has a tetragonal structure with a dielectric constant of 5.2 in the plane of the substrate and 4.6 perpendicular to the substrate surface. It has a good hardness (approximately 575 Knoop) and a linear thermal expansion coefficient that closely matches YBCO and the buffer layers. GRA

**N93-18314#** North Carolina State Univ., Raleigh. Dept. of Electrical and Computer Engineering.
**SOLID-STATE DYNAMICS AND QUANTUM TRANSPORT IN NOVEL SEMICONDUCTOR NANOSTRUCTURES Annual Report, 1 Oct. 1991 - 30 Sep. 1992**
K. W. Kim 30 Sep. 1992 40 p
(Contract N00014-90-J-1835)
(AD-A258482) Avail: CASI HC A03/MF A01

The objective of this research program is to study theoretically the underlying principles of solid-state dynamics and quantum mechanical transport of carriers in ultrasmall novel semiconductor devices. The areas of research to be investigated are the following: (1) theory of optical phonon modes in heterostructures; and (2) quantum transport in solids with special emphasis on the non-perturbative role of high-electric fields, many-body effects, and band-mixing in dynamical processes. These problems will be treated analytically through the development of macroscopic and microscopic physical models with an emphasis on quantum mechanical principles. Specific subjects discussed in this proposal include the effects of confined and interface phonon modes, two-electron quantum transport theory under hot-electron conditions, dielectric response function theory, and the effects of band-mixing in tunneling. The knowledge developed in this work will be of major importance in explaining the novel phenomena and fundamental questions relating to the breakdown of classical solid-state electronics, as device dimensional scales are reduced to the submicron and ultra-submicron regime. Author (GRA)

**N93-18367#** North Carolina State Univ., Raleigh.
**RESEARCH AND DEVELOPMENT ON ADVANCED SILICON CARBIDE THIN FILM GROWTH TECHNIQUES AND FABRICATION OF HIGH POWER AND MICROWAVE FREQUENCY SILICON CARBIDE-BASED DEVICE STRUCTURES Final Technical Report, 1 Apr. 1988 - 31 Dec. 1992**
Robert F. Davis, R. J. Trew, John W. Palmour, R. S. Kern, and P. M. Mock Dec. 1992 78 p
(Contract N00014-88-K-0341)
(AD-A257913) Avail: CASI HC A05/MF A01

Thin films of pure and Al-doped Beta-SiC have been grown on 4 deg off-axis Si(100) and c-axis oriented alpha(6H)SiC in the temperature range of 1025-1250 C using gas-source molecular-beam epitaxy. Cross-sectional TEM confirmed the epitaxial relationship between the films and the substrates. Double positioning boundaries have not been observed in the material grown on the 6H-SiC substrates. Platinum and Ti circular contacts were epitaxially deposited on alpha(6H)-SiC via electron beam MBE at room temperature. Leakage currents at -10V were as low as 5 x 10-18 A/cm(exp 2). The ideality factors were approximately unity. Barrier heights for the as-grown Ti and Pt contacts were determined from C-V measurements to be 0.88 eV and 1.02 eV, respectively. Theoretical investigations of the physical limitations to the RF operation of SiC IMPATT diodes have shown that good RF output power can be obtained from these devices. However, the low magnitude of the charge carrier mobility in SiC limits the magnitude of the RF voltage that can be supported, and thereby prevents efficient dc to RF power conversion. MESFET's have been fabricated with values of f(sub t) and f(sub max), of 4.5 GHz and 3.0 GHz, respectively. The measured DC power density was extremely high with a value of 12.4 W/mm. Solutions to the problems of parasitics from source and gate resistances are described. GRA

**N93-18400#** Virginia Univ., Charlottesville. Dept. of Physics.
**SUPERCONDUCTING MATERIALS PERFORMANCE REPORT, 1 MAY 1992 - 28 FEBRUARY 1993**
J. Ruvalds 1992 15 p
(Contract DE-FG05-84ER-45113)
(DE93-002786; DOE/ER-45113/T4) Avail: CASI HC A03/MF A01

An unusual frequency and temperature variation of the spin susceptibility for electrons or holes whose Fermi surfaces exhibit nesting is discussed. This explains the electronic transport properties of high temperature superconductors (HTS), including optical reflectivity and Raman spectra. Direct evidence for predicted scaling of susceptibility as a function of frequency/T was detected by neutron scattering on two series of cuprate

superconductors. Calculations were extended to electronic structure models for generating lineshapes that may be tested. Good agreement with T and frequency variation of susceptibility measured by neutrons is achieved in the nesting regime. These findings are relevant to anomalous linear temperature variations of electrical resistivity characteristic of HTS. Electron-electron scattering processes become dominant in nested surfaces if the Coulomb interaction between charges is of intermediate strength. DOE

**N93-18412#** California Univ., Berkeley. Lawrence Berkeley Lab.
**THE SYNTHESIS AND STRUCTURAL CHARACTERIZATION OF NOVEL TRANSITION METAL FLUORIDES Ph.D. Thesis**
W. J. Casteel, Jr. Sep. 1992 142 p
(Contract DE-AC03-76SF-00098)
(DE93-002551; LBL-32892) Avail: CASI HC A07/MF A02

High purity KMF6 and K2MF6 salts (M = Mo, Re, Ru, Os, Ir, and Pt) are obtained from reduction hexafluorides. A rhombohedral unit cell is observed for KReF6. Fluoride ion capture by Lewis acids from the hexafluorometallate(IV)salts affords high purity tetrafluorides for M = Mo, Re, Ru, Os, and Pd. The structure of RuF4 is determined from x-ray synchrotron and neutron powder data. Unit cells based on the orthorhombic PdF4 type cell are derived from x-ray powder data for ReF4 and OsF4. Fluoride ion capture from KAgF4 provides the thermally unstable trifluoride as a bright, red, diamagnetic solid. The structure solution of AgF3 and redetermination of the AuF3 structure from x-ray synchrotron and neutron powder data demonstrate that the two are isostructural. The thermal decomposition product of AgF3 is the mixed valence compound Ag(+2)Ag2(+3)F8. Several new salts containing the (Ag-F)n(n+) chain cation are prepared. The first linear (Ag-F)n(n+) chain is observed in AgF(+)BF4(-) which crystallizes in a tetragonal unit. AgFAuF4 has a triclinic unit cell and is isostructural with CuFAuF4. AgFAuF6 has an orthorhombic unit cell and appears to be isostructural with AgFAsF6. A second mixed valence silver fluoride, Ag(+2)Ag(+3)F5, is prepared, which magnetic measurements indicate is probably an AgF(+) salt. Magnetic data for all of the AgF(+) salts exhibit low magnitude, temperature independent paramagnetism characteristic of metallic systems. Cationic Ag(+3) in acidic AHF solutions is a powerful oxidizer, capable of oxidizing Xe to Xe(+2) and O2 to O2(+). Reactions with C6F and C3F6 suggest an electron capture mechanism for cationic Ag(+2) oxidations. DOE

**N93-18425*#** Alabama Univ., Huntsville.
**AUTOMATED DOCUMENTATION GENERATOR FOR ADVANCED PROTEIN CRYSTAL GROWTH Final Technical Report, 7 Nov. 1991 - 31 Jan. 1993**
Gary A. Maddux, Anna Provancha, David Chattam, and Ronald Ford 31 Jan. 1993 367 p
(Contract NAS8-38609)
(NASA-CR-192452; NAS 1.26:192452; UAH-5-32809) Avail: CASI HC A16/MF A03

The System Management and Production Laboratory at the Research Institute, the University of Alabama in Huntsville (UAH), was tasked by the Microgravity Experiment Projects (MEP) Office of the Payload Projects Office (PPO) at Marshall Space Flight Center (MSFC) to conduct research in the current methods of written documentation control and retrieval. The goals of this research were to determine the logical interrelationships within selected NASA documentation, and to expand on a previously developed prototype system to deliver a distributable, electronic knowledge-based system. This computer application would then be used to provide a paperless interface between the appropriate parties for the required NASA document. Author

**N93-18427*#** Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
**THIN FILM PROCESSING OF PHOTOREFRACTIVE BaTiO3 Semiannual Progress Report No. 1**
Paul R. Schuster and Richard S. Potember Oct. 1991 22 p Original contains color illustrations
(Grant NAG1-1247)
(NASA-CR-192194; NAS 1.26:192194) Avail: CASI HC A03/MF A01; 4 functional color pages

The principle objectives of this ongoing research involve the preparation and characterization of polycrystalline single-domain thin films of BaTiO3 for photorefractive applications. These films must be continuous, free of cracks, and of high optical quality. The two methods proposed are sputtering and sol-gel related processing. Author

**N93-18441#** Technische Univ., Delft (Netherlands).
**GROWTH AND PROPERTIES OF CO-EVAPORATED SUPERCONDUCTING YBaCuO THIN FILMS Ph.D. Thesis**
Hubertus Mattheus Appelboom 1992 141 p Sponsored by Philips Research Labs.; Nationaal Onderzoekprogramma Supergeleiding; and Stichting voor Fundamenteel Onderzoek der Materie
(ETN-92-92798) Avail: CASI HC A07/MF A02

The fabrication, analysis, and applications of copper oxide superconducting thin films was studied. Superconducting copper oxides, and YBaCuO system specifically, are introduced. Technical aspects of the particular method that were used for the thin film growth, the evaporation method, are considered. These include: the control of the evaporation flux of electron beam evaporators (a good control of the evaporation flux is very important in obtaining films with desired stoichiometry), the vacuum system, ozone generation, substrate heating and substrate temperature measurement, and stabilization of Knudsen cells. Some of the analysis methods used to characterize the films are discussed and analysis results of the produced films are given. The existing growth processes of YBaCuO films can roughly be divided in two types, the post anneal process and the in situ process. Both processes were used to make YBaCuO films. Properties of films that were made with the post anneal process and with the in situ process are reported. Results obtained making submicrometer structures in YBaCuO films are reported. ESA

**N93-18446#** Universiteit Twente, Enschede (Netherlands).
**OPTICAL AND ELECTRONIC PROPERTIES OF LATTICE-MATCHED AND STRAINED SEMICONDUCTOR SUPERLATTICES Ph.D. Thesis**
Karen Jane Moore 1991 121 p
(ETN-92-92828) Avail: CASI HC A06/MF A02

Spectroscopic investigations of the optical and electronic properties of layered crystalline semiconductor structures are described. Two types of semiconductor structure were studied, the quantum well and the superlattice. The principal experimental techniques employed are photoluminescence and photoluminescence excitation spectroscopy. The effects of electronic coupling on the band alignment of thin GaAs-AlAs quantum well structures are reported. Details of optical properties and electronic structure of short period GaAs-AlAs superlattices are given. The evolution of electronic states of coupled (InGA)As-GaAs quantum wells into superlattice minibands is described. Miniband dispersion in (InGa)As-GaAs strained layer superlattices is considered. Hole state reversal and the role of residual strain in (InGa)As-GaAs superlattices is also considered. ESA

**N93-18514#** Brookhaven National Lab., Upton, NY.
**AREA DETECTORS FOR NEUTRON PROTEIN CRYSTALLOGRAPHY**
B. P. Schoenborn 1992 8 p Presented at the Society of Photo-Optical Instrumentation Engineers International Symposium on Optical Applied Science and Engineering, San Diego, CA, 19-24 Jul. 1992
(Contract DE-AC02-76CH-00016)
(DE93-001973; BNL-47955; CONF-920792-39) Avail: CASI HC A02/MF A01

The main problem in neutron protein crystallography is the low flux of present reactor based or pulsed neutron sources. This low flux is well matched with presently available multiwire area detectors. One way to increase the flux at the sample is to increase the wavelength bandwidth. The conventional technique uses a monochromator with a bandwidth of the order of 1 percent. This bandwidth can be increased by using a multilayer monochromator composed of different 'd' spacings. This provides a large delta lambda increasing the flux manifold. In this case, a reflection in diffraction condition is scanned by the wavelength bandwidth and not by rotation of the reciprocal lattice point through the Ewald sphere. In order to collect most of the simultaneous diffraction, a large cylindrical area detector covering an angular width of 120 degrees with a height of approximately 20 cm is needed. Such a detector should have a spacial resolution of 1.1 mm, an efficiency of 80 percent at 2.0 A and a counting rate of one million events per second. This detector will be subdivided into 4 sectors that will be decoded simultaneously into a Motorola based computer system. This data acquisition system allows time slicing and this

detector is therefore useful for similar experiments using pulsed neutron sources. DOE

**N93-18521#** Brookhaven National Lab., Upton, NY.
**INTERFACIAL REACTION IN a-Si/Au AND a-Si/Cu THIN FILM BILAYERS**
S. M. Heald and Z. Tan 1992 5 p Presented at the 7th International Conference on X Ray Absorption Fine Structure, Kobe, Japan, 23-29 Aug. 1992
(Contracts DE-AC02-76CH-00016; DE-AS05-80ER-10742)
(DE93-002324; BNL-47544; CONF-9208160-4) Avail: CASI HC A01/MF A01

The interdiffusion and compound formation at the a-Si/Au and a-Si/Cu thin film interfaces using x-ray reflectivity and grazing incidence Extended X-ray Absoprtion Fine Structure (EXAFS) techniques are studied. In the 0 C as-deposited samples, reaction between Si and Au is minimal, but reaction between Si and Cu is significant. Upon annealing for ten minutes in argon, the a-Si crystallized and reacted quite extensively with Au at 160 C. Further reaction between Si and Cu proceeded at 130 C. The compounds formed appear to be metal-rich silicides in both the Si/Au and Si/Cu systems. For Au/Si the silicide is likely stabilized on the surface of the newly formed crystallites. DOE

**N93-18593*#** Auburn Univ., AL. Dept. of Mechanical Engineering.
**DETERMINATION OF CLEAVAGE PLANES AND FRACTURE CHARACTERIZATION OF Ni-BASED SINGLE CRYSTAL SUPERALLOYS Final Progress Report**
John M. Merrill and Roy C. Wilcox 1 Dec. 1992 25 p
(Grant NAG8-188)
(NASA-CR-191932; NAS 1.26:191932) Avail: CASI HC A03/MF A01

The room temperature fracture behavior of the Ge Rene N-4, CMSX-2, and CMSX-4C single crystal Ni-based superalloys was studied. All crystals were grown along the (001) direction and tensile tested in both helium and hydrogen atmospheres. A stereoscopic technique developed for use with a scanning electron microscope was applied to determine cleavage planes. Planar gamma(') morphologies also were examined to help determine cleavage planes. Helium charged specimens failed on a number of planes including the (111), (110), and (320). In most cases planes of the (111)-type initiated at the notch region and became smaller and smaller as they moved in radially. Tensile strengths in helium averaged 1000 MPa higher than that of the hydrogen charged specimens. Specimens tested in hydrogen generally failed on (100)-type planes originating from the notch region. This (100) region comprised 60 to 80 percent of the total fracture surface on most samples and appeared as large flat planes perpendicular to the growth direction of the crystal. The interior regions contained (100)-type planes as well as (321), (320), (210), and (111)-types. Hydrogen charged specimens also showed a high percentage of large cracks oriented at 90 deg to one another, indicative of the (100)-type fracture. The Ge Rene N4 and the CMSX-4C samples contained 3-5 percent gamma/gamma(') eutectic, while the CMSX-2 samples had little or no gamma/gamma(') eutectic. The relationship between gamma/gamma(') eutectic and the fracture surface has not been fully determined, but it is thought that the gamma/gamma(') eutectic may serve as a possible trapping site for hydrogen. Author

**N93-18618#** Oak Ridge National Lab., TN.
**A NEUTRON SCATTERING STUDY OF THE QUASI-ONE-DIMENSIONAL, DILUTE ISING-LIKE ANTIFERROMAGNET CsCo(0.83)Mg(0.17)Br3**
R. B. Rogge, B. D. Gaulin, and Y. S. Yang 1992 10 p Presented at the Conference on Magnetism and Magnetic Materials, Houston, TX, 1-4 Dec. 1992
(Contract DE-AC05-84OR-21400)
(DE93-001718; CONF-921201-6) Avail: CASI HC A02/MF A01

Neutron scattering measurements have been performed on a single crystal sample of CsCo(0.83)Mg(0.17)Br3, a quasi-one-dimensional, Ising-like, antiferromagnet. Residual three-dimensional interactions between the dilute magnetic chains precipitate a phase transition to long range order at T(sub N) is approximately 8.5 K, and short range correlations persist as high as 40 K. Relatively high energy inelastic scattering from both 'bulk' spin wave modes and 'end' modes is observed from the finite chains. The low energy inelastic spectrum is dominated by soliton scattering due to anti-phase domain walls propagating along the finite chains. DOE

**N93-18619#** EG and G Energy Measurements, Inc., Idaho Falls.
**SINGLE PARAMETER ANALYSIS OF HYSTERETIC MAGNETIC FLUX TRAPPING IN HIGH T(SUB c) SUPERCONDUCTOR RIBBON**
K. L. Telschow 1992 6 p Presented at the Review of Progress in Quantitative Non Destructive Evaluation, La Jolla, CA, 19-24 Jul. 1992
(Contract DE-AC07-76ID-01570)
(DE93-001924; EGG-M-92280; CONF-920799-2) Avail: CASI HC A02/MF A01

This paper describes the application of an AC surface probe, similar to presently used eddy current probes, to the measurement of DC transport critical currents and critical state dissipation in high T(sub c) superconductors. It has been shown that the probe can provide quantitative measurement of the full field penetration in superconducting samples by measuring the response of AC induced screening currents for superconducting materials in the form of tapes with overlayers of silver. In this manner, the AC probe can be used to replace the contact DC probe for determining critical currents in a noncontacting and local manner suitable for scanning over or along the sample. DOE

**N93-18620#** Ohio State Univ., Columbus.
**OPTICAL AND MAGNETIC SIGNATURES OF LOCALIZED EXCITATIONS IN POLYANILINE**
W. P. Su (Houston Univ., TX.), A. J. Epstein, and J. Kim (Houston Univ., TX.) 1992 6 p
(Contract DE-FG02-88ER-45347)
(DE93-001954; DOE/ER-45347/51) Avail: CASI HC A02/MF A01

Using a tight-binding Hamiltonian, we study the lattice configurations and electronic structures of three forms of polyaniline: leucoemeraldine base (LEB), emeraldine base (EB), and pernigraniline base (PNB). Both bond length and ring rotation angle are considered in the structure relaxation. The dominant elementary excitations of isolated chains are found to be solitons in PNB and bipolarons in EB and in LEB. Optical absorptions of the ground states and of the solitonic and polaronic excitations are calculated and compared with experiments. The spin density profile of a single neutral soliton in PNB is discussed in connection with magnetic measurements. DOE

**N93-18892#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CATHODOLUMINESCENCE SPECTROSCOPY OF ZINC GERMANIUM PHOSPHIDE ZnGeP2 M.S. Thesis**
Michael R. Gregg 3 Dec. 1992 108 p
(AD-A258996; AFIT/GEP/ENP/92D-4) Avail: CASI HC A06/MF A02

Zinc Germanium Phosphide (ZnGeP2) is a nonlinear semiconductor suitable for use as a laser tuning element over the two to six micron wavelength range. Although this crystal has been studied in the past, its luminescent properties are not yet well understood. In this present study, ZnGeP2 has been examined using cathodoluminescence spectroscopy (CL). Specifically, the spectral dependence of the CL was obtained as a function of electron beam energy, beam current, and temperature. The resulting CL was found to be polarized with a peak structure that was dependent on the polarization. This peak structure observed by CL is difficult to detect by photoluminescence (PL). It is believed that the peaks are due to transitions between the conduction band and the spin orbit split acceptor level ALI. It is also believed that the excitation mechanism is in part responsible for the different structure observed. GRA

**N93-18980#** Army Research Lab., Aberdeen Proving Ground, MD.
**EFFECTS OF SURFACE STRUCTURE AND OF EMBEDDED-ATOM PAIR FUNCTIONALS ON ADATOM DIFFUSION ON FCC METALLIC SURFACES Final Report, Jul. 1988 - Jan. 1992**
Betsy M. Rice, Cheruvu S. Murthy, and Bruce C. Garrett Nov. 1992 41 p
(DA Proj. 1L1-61102-AH-43)
(AD-A258793; ARL-TR-5) Avail: CASI HC A03/MF A01

Rates of self-diffusion on the (100) and (110) surfaces of nickel have been calculated using variational transition state theory (VTST) and four different interatomic potential energy functions based on the embedded-atom method (EAM). Static properties of a single nickel atom on the (111) surface, as well as on the (100) and (110) surfaces, are also presented. The embedded-atom par functionals consist of effective pairwise additive and many-body cohesive interactions parameterized to the bulk and a few

defect properties of nickel. VTST calculations of surface diffusion provide parameters and diffusion coefficients for comparison with experiment and among the four EAM potentials employed. analysis of the estimated diffusion rates based on hopping mechanism and the four pair functionals reveals that diffusion will occur more readily on (111) surface and that self-diffusion on (110) surface exhibits directional anisotropy. Diffusion rate variation from one par functional to another is interpreted in terms of the effective pair potentials. GRA

**N93-18983#** North Carolina State Univ., Raleigh.
**GROWTH, NITROGEN VACANCY REDUCTION AND SOLID SOLUTION FORMATION IN CUBIC GaN THIN FILMS AND THE SUBSEQUENT FABRICATION OF SUPERLATTICE STRUCTURES USING AlN AND InN Final Report, 1 Jun. 1986 - 31 Dec. 1992**
Robert F. Davis Dec. 1992 59 p
(Contract N00014-86-K-0686)
(AD-A258804) Avail: CASI HC A04/MF A01

An atomic layer epitaxy deposition system configured for the growth of thin films of the III-V nitrides of Al, Ga, and In has been designed, constructed and commissioned. The system allows the introduction of up to 16 gases without mixing. Self-terminating growth of crystalline GaN films has been achieved on single crystal wafers of (0001) alpha(6H)-SiC. Results of analyses via Auger spectroscopy, electron microscopy and electron diffraction are described. Deposition of AlN and GaN via gas-source MBE was also continued during this period. The principal emphasis concerned the initial stages of growth of both compounds on the substrates of (00001) alpha(6H)-SiC and (0001) sapphire, as determined using X-ray photoelectron spectroscopy. An initial layer of silicon nitride formed on the surface of SiC prior to the deposition of either nitride. The deposition of GaN on sapphire followed the Stranski-Krastanov mode of nucleation and growth, while on SiC, characteristics of three-dimensional growth were evident. By contrast, AlN grew initially in a layer-by-layer mode. Deposition of GaN on vicinal (100) Beta-SiC during UV irradiation resulted in the formation of a new 4H polytype of this material. Deposition of BN via gas-source MBE on Cu(110) resulted in nanocrystalline cBN; films grown on (111) Cu resulted in h-BN (graphitic phase). Similar studies using Si(100) substrates also resulted in the occurrence of cBN. The occurrence of the cubic polytype was enhanced while that of h-BN was discouraged with the use of the UV light at 400-500 C. GRA

**N93-18991#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**EXCITATION AND DE-EXCITATION MECHANISMS OF Er-DOPED GaAs AND AlGaAs Ph.D. Thesis**
David W. Elsaesser Dec. 1992 244 p
(AD-A258814; AFIT/DS/ENP/92-05) Avail: CASI HC A11/MF A03

Electrical and optical characterization have been performed on GaAs and Al(x)Ga(1-x)As samples doped with Er either by ion implantation or during Molecular Beam Epitaxial (MBE) growth. Deep Level Transient Spectroscopy (DLTS) and Temperature-Dependent Hall Effect (TDH) measurements indicated the presence of two hole traps in Er-doped GaAs, at 35 and 360 meV above the valence band maximum. The former (shallower) center was thought to be due to Er substituting for a Ga atom (ErGa) and giving rise to an isoelectronic impurity potential. The second center was attributed to an Er atom occupying an interstitial position (Er(i)). Annealing studies performed on Er-implanted GaAs indicated that the ErGa center preferentially formed at higher annealing temperatures (greater than 850 C), with the Er(i) reaching a maximum concentration at an annealing temperature of around 750 C. Optical characterization performed by Photoluminescence (PL) measurements showed that the Er(i) center gave a much stronger Er-related intra-4f shell emission. Mechanisms for the excitation of the 4f shells of these two centers are discussed. Similar optically active Eri centers may be forming in AlGaAs. GRA

**N93-19064#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CATION PRODUCTION AND REACTIONS INDUCED BY ELECTRON IMPACT ON TETRAETHOXYSILANE M.S. Thesis**
Jeremy C. Holtgrave Dec. 1992 100 p
(AD-A258830; AFIT/GEP/ENP/92D-06) Avail: CASI HC A05/MF A02

The production of cations by electron impact on tetraethoxysilane (TEOS) is studied with a Fourier Transform Mass Spectrometer (FTMS). The operating principles of FTMS are reviewed and the experimental approach to the mass calibration and cross-section measurement is discussed. The cross-sections for total and partial ionization of Si(OC2H5) from threshold to 50 eV are measured. Also, the ion chemistry resulting from interactions between ions and neutral TEOS is examined. GRA

**N93-19088#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**PHASE CONJUGATION IN OPTICAL FIBER VIA STIMULATED BRILLOUIN SCATTERING WITH FEEDBACK FROM A BARIUM TITANATE CRYSTAL M.S. Thesis**
Patrick R. Emmert Dec. 1992 51 p
(AD-A258824; AFIT/GEP/ENP/92D-02) Avail: CASI HC A04/MF A01

The goal of this thesis was to obtain phase conjugation in multi-mode optical fiber via stimulated Brillouin scattering (SBS) with the aid of a barium titanate crystal which formed a phase conjugate cavity for the Stokes beam. SBS was demonstrated but the SBS threshold was unaffected by the presence of the barium titanate crystal and no evidence for the presence of phase conjugation in the optical fiber was obtained. GRA

**N93-19467#** Midwest Research Inst., Golden, CO.
**SECOND WORKSHOP ROLE OF POINT DEFECTS/DEFECT COMPLEXES IN SILICON DEVICE FABRICATION Abstracts Only**
1992 59 p Workshop held in Breckenridge, CO, 24-26 Aug. 1992
(Contract DE-AC02-83CH-10093)
(DE92-016424; NREL/CP-413-5064; CONF-9208175-Absts) Avail: CASI HC A04/MF A01

Abstracts are presented of 24 papers. The papers are arranged under the following session/panel headings: defects and impurities in commercial photovoltaic Si substrates; point defects and point defect processes; impurity gettering for Si solar cells; gettering in Si solar cells; and passivation of impurities and defects. DOE

**N93-19488#** California Univ., Berkeley. Lawrence Berkeley Lab.
**ELECTRON CORRELATIONS IN SEMICONDUCTORS: BULK COHESIVE PROPERTIES AND MAGNETIC-FIELD-INDUCED WIGNER CRYSTAL AT HETEROJUNCTIONS**
S. G. Louie and X. Zhu Aug. 1992 8 p Presented at the 21st International Conference on the Physics of Semiconductors, Beijing, China, 10-14 Aug. 1992
(Contract DE-AC03-76SF-00098)
(DE93-002626; LBL-32833; CONF-920825-2) Avail: CASI HC A02/MF A01

A correlated wavefunction variational quantum Monte Carlo approach to the studies of electron exchange and correlation effects in semiconductors is presented. Applications discussed include the cohesive and structural properties of bulk semiconductors, and the magnetic-field-induced Wigner electron crystal in two dimensions. Landau level mixing is shown to be important in determining the transition between the quantum Hall liquid and the Wigner crystal states in the regime of relevant experimental parameters. DOE

**N93-19490#** Brookhaven National Lab., Upton, NY.
**ELECTRON YIELD XAFS STUDY OF EVAPORATED Co/Pd MULTILAYERS WITH VARIOUS THICKNESS RATIOS OF Co TO Pd SUBLAYERS: SIMULATIONS OF THE Co K-EDGE XAFS AND FOURIER TRANSFORMS**
M. Choi (Catholic Medical Coll., Seoul, Republic of Korea ), J. H. Joo (Korea Advanced Inst. of Science and Technology, Seoul, Republic of Korea ), S. K. Kim (Research Inst. of Industrial Science and Technology, Pohang, Republic of Korea ), J. S. Kang (Research Inst. of Industrial Science and Technology, Pohang, Republic of Korea ), and Y. P. Lee (Research Inst. of Industrial Science and Technology, Pohang, Republic of Korea ) 1992 4 p Presented at the 7th International Conference on X Ray Absorption Fine Structure, Kobe, Japan, 23-29 Aug. 1992
(Contract DE-AC02-76CH-00016)
(DE93-003142; BNL-48084; CONF-9208160-5) Avail: CASI HC A01/MF A01

Electron-yield XAFS measurements using the NSLS were made on e-beam evaporated Co/Pd multilayers with various sublayer thicknesses and different thickness ratios of Co to Pd sublayers. The Co K-edge and the Pd K-edge XAFS data were obtained for the Co/Pd multilayers with

sublayer thicknesses of 3 A/4 A, 15 A/4 A, 3 A/15 A, 2.1 A/13.5 A, and 2.2 A/4.5 A. Fourier transforms of Co K XAFS for most samples show a splitting of major peak, and the magnitude ratio of these split peaks varies systematically with the thickness ratio of the Pd sublayer to the Co sublayer, whereas the Fourier transforms of the Pd K XAFS for the same samples do not show a splitting of peaks. As a preliminary analysis, the Co K XAFS and the split peaks in the Fourier transform for the Co/Pd(3 A/4 A) case were simulated by using the FEFF calculations, and the Co K XAFS and the major peak in the fourier transform for the Co/Pd(15 A/4 A) case were also simulated consistently. DOE

**N93-19497#** Argonne National Lab., IL.
**POSITRON ANNIHILATION STUDIES OF THE ELECTRONIC STRUCTURE AND FERMIOLOGY OF THE HIGH-T(SUB c) SUPERCONDUCTORS**
L. C. Smedskjaer and A. Bansil (Northeastern Univ., Boston, MA.) Sep. 1992 24 p Presented at the 10th Sagamore Conference on Charge, Spin and Momentum Densities, Konstanz, Germany, 1-7 Sep. 1992
(Contract W-31-109-eng-38)
(DE93-002982; ANL/MSD/CP-77606; CONF-9209267-1) Avail: CASI HC A03/MF A01

We discuss the application of the positron annihilation angular correlation (ACAR) spectroscopy for investigating the electronic structure and Fermiology of the high-T(sub c) superconductors, with focus on the YBa2Cu3O7 system where most of the experimental and theoretical work has to date been concentrated. Comparisons between measured 2D-ACAR positron spectra and band theory predictions show a remarkable agreement (for the normal state), indicating that the electronic structure and Fermi surface of this material is described reasonably by the conventional picture. DOE

**N93-19498#** Argonne National Lab., IL.
**GENERIC PROPERTIES OF LAYERED SUPERCONDUCTORS**
R. A. Klemm Oct. 1992 9 p Presented at the 6th Annual New York State Institute on Superconductivity (NYSIS) Conference on Superconductivity and Applications, Buffalo, NY, 15-17 Sep. 1992
(Contract W-31-109-eng-38)
(DE93-002985; ANL/MSD/CP-77834; CONF-920944-5) Avail: CASI HC A02/MF A01

A wide variety of layered materials have been found to be superconducting. Among these are graphite intercalation donor compounds, transition metal dichalcogenides, intercalated transition metal dichalcogenides, organic layered superconductors, artificial superlattices, and the cuprates. The normal state properties of all of these compounds are very similar, due to the fact that they all have well-defined Fermi surfaces, and quasi-linear in-plane resistivities at high temperatures. At lower temperatures, charge- or spin-density waves are common in these systems. With the exception of the graphite intercalation compounds, all of the layered superconductors are type-2, and generally highly anisotropic in their superconducting properties. Dimensional crossover from anisotropic bulk to thin film behavior is common to many of these materials. DOE

**N93-19617#** California Univ., Berkeley. Lawrence Berkeley Lab.
**RESPONSE OF A Nb/Al2O3/Nb TUNNEL JUNCTION TO PICOSECOND ELECTRICAL PULSES**
C Karadi, S. Verghese, C. A. Mears, J. O. Orenstein, P. L. Richards, and A. T. Barfknecht (Conductus, Inc., Sunnyvale, CA.) Sep. 1992 5 p Presented at the Optical Society of America (OSA) Meeting on Ultrafast Optics and Optoelectronics, San Francisco, CA, 25-27 Jan. 1993
(Contract DE-AC03-76SF-00098)
(DE93-002625; LBL-32901; CONF-930150-1) Avail: CASI HC A01/MF A01

Picosecond electrical pulses were used to measure the broadband quasiparticle response of a Nb trilayer SIS (superconductor insulator superconductor) junction in both the linear and nonlinear regimes. The electrical pulses were generated by illuminating a Si photoconducting switch using a Ti-sapphire laser. The SIS response is inferred by measuring the dc current induced by interfering two electrical pulses at the junction, as a function of the time delay between them. Results are obtained for bias voltages of 1.0 and 2.0 mV; at the latter, two-photon absorption was detected. DOE

**N93-19627#** Argonne National Lab., IL.
**ION BEAM-BASED CHARACTERIZATION OF MULTICOMPONENT OXIDE THIN FILMS AND THIN FILM LAYERED STRUCTURES**
A. R. Krauss, M. Rangaswamy, Yuping Lin, D. M. Gruen, J. A. Schultz (Ionwerks, Houston, TX.), H. K. Schmidt (Schmidt Instruments, Houston, TX.), and R. P. H. Chang (Northwestern Univ., Evanston, IL.) 1992 30 p Presented at the NATO Advanced Study Institute on Multicomponent and Multilayered Thin Films for Advanced Microtechnologies, Techniques, Fundamentals and Devices, Bad Windsheim, Germany, 22 Sep. - 6 Oct. 1992
(Contract W-31-109-eng-38)
(DE93-003004; ANL/CHM/CP-73956; CONF-9209264-1) Avail: CASI HC A03/MF A01

Fabrication of thin film layered structures of multi-component materials such as high temperature superconductors, ferroelectric and electro-optic materials, and alloy semiconductors, and the development of hybrid materials requires understanding of film growth and interface properties. For High Temperature Superconductors, the superconducting coherence length is extremely short (5-15 (Angstrom)), and fabrication of reliable devices will require control of film properties at extremely sharp interfaces; it will be necessary to verify the integrity of thin layers and layered structure devices over thicknesses comparable to the atomic layer spacing. Analytical techniques which probe the first 1-2 atomic layers are therefore necessary for in-situ characterization of relevant thin film growth processes. However, most surface-analytical techniques are sensitive to a region within 10-40 A of the surface and are physically incompatible with thin film deposition and are typically restricted to ultra high vacuum conditions. A review of ion beam-based analytical methods for the characterization of thin film and multi-layered thin film structures incorporating layers of multicomponent oxides is presented. Particular attention will be paid to the use of time-of-flight techniques based on the use of 1- 15 key ion beams which show potential for use as nondestructive, real-time, in-situ surface diagnostics for the growth of multicomponent metal and metal oxide thin films. DOE

**N93-19634#** Miami Univ., Oxford, OH.
**MAGNETIC MULTILAYER INTERFACE ANISOTROPY**
M. J. Pechan 1992 7 p
(Contract DE-FG02-86ER-45281)
(DE93-004951; DOE/ER-45281/7) Avail: CASI HC A02/MF A01

Ni/Mo and Ni/V multilayer magnetic anisotropy has been investigated as a function of Ni layer thickness, frequency and temperature. Variable frequency ferromagnetic resonance (FMR) measurements show, for the first time, significant frequency dependence associated with the multilayer magnetic anisotropy. The thickness dependence allows one to extract the interface contribution from the total anisotropy. Temperature dependent FMR (9 GHz) and room temperature magnetization indicate that strain between Ni and the non-magnetic layers is contributing significantly to the source of the interface anisotropy and the state of the interfacial magnetization. In order to examine the interface properties of other transition metal multilayer systems, investigations on Fe/Cu are underway and CoCr/Ag is being proposed. ESR measurements have been reported on Gd substituted YBaCuO superconductors and a novel quasi-equilibrium method has been developed to determine quickly and precisely the transition temperature. DOE

**N93-19643#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**POLYCRYSTALLINE TETRAGONAL ZIRCONIA IN THE SYSTEM CeO2-ZrO2 (Ce-TZP) [CERAMICAS DE ZIRCONIA TETRAGONAL POLICRISTALINA NO SISTEMA CEO2-ZRO2 (CE-TZP)]**
Maria doCarmo deAndradeNono 1991 155 p In PORTUGESE
(INPE-5285-TAE/007) Avail: CASI HC A08/MF A02

The development and the characterization of CeO2-stabilized tetragonal ZrO2 polycrystals (Ce-TZP ceramics) is presented since it is considered candidate material for applications as structural high performance ceramics. Sintered ceramics were fabricated from mixtures of powders containing different CeO2 content prepared by conventional and nonconventional techniques. The choice of these techniques of powder preparation was based on confiability and reproductibility of the resultant ceramics. It utilized conventional oxide mixtures (CeO2 and ZrO2) for manufacture of some Ce-TZP ceramics for comparative studies. The nonconventional technique of powder preparation that was developed and/or optimized were a

coprecipitation of hydrous oxides and drying by conventional and freeze methods, and precipitation and drying of Ce and Zr with low polarity alcohols. These powders and their resultant sintered ceramics were specified by chemical and physical characterization, compactation state, and mechanical properties. The chemical characteristics were determined by chemical analysis and the physical characteristics were evaluated by phase content, particle and agglomerate size and aspect, and powder porosity. The compactation state was analyzed from porosimetry results and electronic microscopy observations. It adopted the bending strength, Vickers hardness, and fracture toughness techniques to the determination of the mechanical properties. The mechanical properties were strongly dependent on the CeO2 content, the microstructure, and the fraction of tetragonal-to-monoclinic stress-induced transformation. Some Ce-TZP ceramics fabricated showed mechanical property values that can be comparable to those published in the international literature. Author

**N93-19742#** Brookhaven National Lab., Upton, NY.
**THE EFFECTS OF HEAVY-ION IRRADIATION OF SUPERCONDUCTIVITY IN YBa2Cu3O7 EPITAXIAL FILMS**
R. C. Budhani, Y. Zhu, and M. Suenaga 1992 4 p Presented at the Applied Superconductivity Conference, Chicago, IL, 23-28 Aug. 1992
(Contract DE-AC02-76CH-00016)
(DE93-002325; BNL-47369; CONF-920802-28) Avail: CASI HC A01/MF A01

We report a comparative study of the superconducting behavior in YBa2Cu3O7 epitaxial films irradiated with Ag and Au ions of several hundred MeV energy. The irradiation results in columnar defects of average diameter (approximately) 55 and (approximately) 110 A for Ag(+21) and Au(+24) ions respectively. A universal linear scaling is observed between the fractional areal damage vs. the superconducting transition temperature and normal state resistivity. Our results also show that in these films with intrinsically strong pinning, a marginal enhancement in the critical current density (J(sub c)) occurs when the defect density is less than 5(10)(exp 10)/sq cm and the defect diameter is of the order of coherence length. This criterion is satisfied by the silver ions. The damage due to Au(+24) ions is much too severe to improve the J(sub c). DOE

**N93-19755#** Argonne National Lab., IL.
**MAGNETIC STRUCTURES OF NANOMETER SCALE Dy, Cr, AND Ni**
M. R. Fitzsimmons (Los Alamos National Lab., NM.), R. A. Robinson (Los Alamos National Lab., NM.), A. C. Lawson (Los Alamos National Lab., NM.), G. H. Kwei (Los Alamos National Lab., NM.), K. E. Sickafus (Los Alamos National Lab., NM.), J. A. Eastman, and E. Burkel (Ludwig-Maximilians-Univ., Munich, Germany ) Oct. 1992 7 p Presented at the Conference on Nanostructured Materials, Cancun, Mexico, 21-25 Sep. 1992
(Contracts W-31-109-eng-38; W-7405-eng-36)
(DE93-002984; ANL/MSD/CP-77654; LA-UR-92-3385; CONF-920947-4)
Avail: CASI HC A02/MF A01

Materials composed of nanometer-sized structures are becoming technologically relevant as the sizes of electronic devices approach the nanometer scale. Questions as to the performance and durability of these devices can be partially addressed through the characterization and understanding of the magnetic structures and properties of nanometer-sized materials. The purpose of the present work is to understand the relationship between the microstructure of nanocrystalline materials and their magnetic structures and properties. This paper summarizes three separate experiments: (1) an X-ray diffraction and anomalous absorption (XANES) study of nanocrystalline Dy; (2) neutron diffraction measurements of the magnetic structure of nanocrystalline Cr; and (3) the measurement of the magnetization density of a single twist grain boundary in Ni. DOE

**N93-19826#** Lawrence Livermore National Lab., CA.
**SUPERCONDUCTING TUNNEL JUNCTION X-RAY DETECTORS WITH NIOBIUM ABSORBERS AND ALUMINUM QUASIPARTICLE TRAPS**
S. E. Labov, C. A. Mears, G. W. Morris, C. E. Cunningham, M. A. LeGros, E. H. Silver, A. T. Barfknecht (Conductus, Inc., Sunnyvale, CA.), N. W. Madden, and D. A. Landis 1992 13 p Presented at the Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium on Optical Applied Science and Engineering, San Diego, CA, 19-24 Jul. 1992
(Contracts DE-FG03-91ER-81109; W-7405-eng-48)
(DE93-002885; UCRL-JC-111508; CONF-920792-42) Avail: CASI HC A03/MF A01

We are developing superconducting tunnel junction devices for use as high-resolution, high-efficiency x-ray spectrometers. We have tested devices with niobium x-ray absorbing layers coupled to aluminum layers which serve as quasiparticle traps. These devices were fabricated photolithographically using a modified niobium/aluminum/niobium trilayer fabrication process. Our first devices have a very thin barrier with specific normal state resistance of 1.5 x 10(exp -6) Ohm cm(exp 2), and also exhibit very low leakage current of 15nA below 200 mK. The energy resolution at 6 keV is 1990 eV FWHM, and is limited both by electronic noise and by the non-linear response of the detector. DOE

**N93-19827#** Lawrence Livermore National Lab., CA.
**MICROPHOTOGRAPHY OF SHOCKS IN CRYSTALS**
A. M. Frank 20 Aug. 1992 10 p Presented at the 20th International Congress on High Speed Photography and Photonics, Victoria, British Columbia, 25-26 Sep. 1992
(Contract W-7405-eng-48)
(DE93-002888; UCRL-JC-108962; CONF-9209188-6) Avail: CASI HC A02/MF A01

Recent advances in high-speed photographic capabilities of Micro Detonics Facility (micro DF) and miniature electric gun drivers have allowed real-time stop motion examination of shock waves passing through single crystals. Examination of defects and growth of dislocations from greater than 5 GPa shocks, requires temporal resolutions of a nanosecond or better and spatial resolutions better than 10 micron. As the defects and dislocations are highly inhomogeneous, simultaneous frame and streak records of the same location within the crystal are also required. Cameras and laser illuminators, discussed previously, have been upgraded and combined into a coaxial streak and frame system. Both laser beams are tailored and aimed separately. The dye laser is spatially filtered and focused to cover the frame. The argon laser is focused to a line on the target which is then imaged to the streak camera slit. The ability to see the focal line of the argon laser on the frame camera allows precise collocation of the fields of view of the two cameras. The focused argon laser and the slit are confocal resulting in the ability to obtain good streak data for crystals of poor optical quality. DOE

**N93-19830#** Argonne National Lab., IL.
**LIQUID TELLURIDES: STRUCTURE AND PROPERTIES**
M. L. Saboungi, J. Fortner, J. W. Richardson, A. Petric (McMaster Univ., Hamilton, Ontario ), M. Doyle (Northwestern Univ., Evanston, IL.), and J. E. Enderby (Bristol Univ., England ) Oct. 1992 18 p Presented at the 8th International Conference on Liquid and Amorphous Metals, Wien, Austria, 31 Aug. - 4 Sep. 1992
(Contract W-31-109-eng-38)
(DE93-002909; ANL/MSD/CP-75815; CONF-9208177-1) Avail: CASI HC A03/MF A01

In this paper a review of the thermodynamic, electrical and structural properties of liquid alkali-tellurium alloys is presented with a special emphasis on the interplay between these properties. The thermodynamic properties indicate ordering of the solutions at compositions corresponding to about 12, 50, and 67 atom percent of alkali atoms. The electrical conductivity and thermopower data confirm that these liquids are true semiconductors. The neutron diffraction patterns coupled with the above information indicate that in the case of liquid K(0.12)Te(0.88) the measured structure is dominated by the Te-Te contribution, and is remarkably similar to that of pure liquid tellurium, while the equiatomic alloy K(0.50)Te(0.50) is shown to contain mostly Te pairs which are identified with Zintl ions, Te2(2-). DOE

**N93-19848#** North Carolina State Univ., Raleigh.
**ATOMIC LAYER EPITAXY GROUP 4 MATERIALS: SURFACE PROCESSES, THIN FILMS, DEVICES AND THEIR CHARACTERIZATION Annual Report, 1 Jan. 1992 - 31 Dec. 1992**
Robert F. Davis, Salah Bedair, Nadia El-Masry, and Jeffrey T. Glass Dec. 1992 34 p
(Contract N00014-91-J-1416)
(AD-A259244) Avail: CASI HC A03/MF A01

An integrated growth and surface characterization system containing a hot filament reactor, sample transfer station, ESD, and XPS was established to investigate the ALE of diamond films. Complementary experiments

concerned with the nucleation of diamond on molten surfaces, e.g., Al and Ge were also conducted. Formation of GeO2 or an aluminum carbide and the degradation of the diamond by the molten material inhibited nucleation on the melted area. Monocrystalline thin films of Beta-SiC were achieved in the temperature range of 850-980 C by atomic layer-by-layer deposition of Si and C species via sequential exposures of Si(100) substrates to Si2H6 and C2H4. A UHV analytical system containing TPD, AES, and XPS is being constructed in concert with the SiC ALE studies to determine the reaction chemistry important to this process. An eximer laser ablation system for the ALE of CeO2 has been completed and employed to successfully deposit films of this material on Si(100). GRA

**N93-19862#** Stevens Inst. of Tech., Hoboken, NJ. Dept. of Chemistry and Chemical Engineering.

**THEORETICAL AND STM STUDIES OF THE ELECTRONIC STRUCTURE OF METAL/SEMICONDUCTOR/HYDROGEN SYSTEMS Final Report, 1 Feb. 1991 - 14 Aug. 1992**

Walter C. Ermler 19 Nov. 1992 76 p

(Grant AF-AFOSR-0164-91)

(AD-A258693; Rept-5-27081; AFOSR-92-1024TR) Avail: CASI HC A05/MF A01

The structure of atomic clusters is investigated using methods of ab initio quantum chemistry in conjunction with scanning tunneling microscopy (STM). Gold sols are imaged via STM and their sizes characterized. Atomic resolution reveals facets, steps, and reconstructed surfaces of the sols. STM images of graphite surfaces are characterized by two mechanisms: a twisted top layer configuration and a graphite-flake contaminated tip. A crystalline tip model reproduces anomalous long range periodicity, attributed to defect-mediated tip-substate convolution. Ab initio calculations of electronic states of a 135 atom Be cluster show bulk behavior for many properties centered at the middle of the cluster. The density of states agrees well with band theory models. Full spin-orbit CI calculations of the electronic spectrum and potential energy curves of LiBe, including Rydberg states, are definitive and accurate. A procedure for the incorporation of core/valence polarization effects in all-valence electron calculations is presented for use with relativistic effective core potentials. The method allows the treatment of large clusters at the ab initio level including procedures for the inclusion of electron correlation. GRA

**N93-19863#** Rutgers - The State Univ., New Brunswick, NJ. Dept. of Mathematics.

**GEOMETRY OF ENERGY MINIMIZING SURFACES Final Report, 1 Oct. 1990 - 31 Jan. 1992**

Jean E. Taylor 31 Jan. 1992 8 p

(Grant AF-AFOSR-0010-91)

(AD-A258694; AFOSR-92-1029TR) Avail: CASI HC A02/MF A01

During this period of support they have continued long-term program of investigating the shapes of surfaces in mathematical models for crystals (including polycrystalline materials), both in equilibrium and in growth. The accomplishments included the completion of seven papers, all of which have either appeared in print or are in press, and working on five more, three of which have since been finished and accepted for publication. Also completed one videotape that will soon be published. Four Papers that had previously been written appeared in print during the period of this grant. In addition, one AMA Special Session was organized and one week long workshop at The Geometry Center, and initiated and edited the proceedings of both (the second after this grant expired). These proceedings are highly innovative in that they include videotapes. The PI gave a large number of invited talks at a variety of meetings. GRA

**N93-19881#** Wichita State Univ., KS. National Inst. for Aviation Research.

**X RAY CHARACTERIZATION OF Au/Ni MULTILAYER THIN FILMS**

J. Chaudhuri, S. M. Alyan, and A. F. Jankowski (Lawrence Livermore National Lab., CA.) May 1992 21 p

(NIAR-92-7) Avail: CASI HC A03/MF A01

Au/Ni multilayer thin films of single phase structure are analyzed using kinematical x-ray diffraction theories to determine the composition modulation and structure of this multilayer system. The repeat period of the multilayers used ranges from 0.82x10(exp -9) m to 4.26x10(exp -9) m. The composition modulation is found to be a near square wave. The strain at the Au/Ni interface is predicted to be 9.8 percent at repeat period 1.65x10(exp -9) m with decreasing values above and below this repeat period. Author

**N93-19954#** Duke Univ., Durham, NC. Dept. of Chemistry.

**X RAY CRYSTAL STRUCTURE OF InCl3(DOT)2THF, A NEURAL FIVE-COORDINATE BIS-ADDUCT OF AN In3 TRIHALIDE**

Mark F. Self, Andrew T. McPhail, and Richard L. Wells 18 Nov. 1992 6 p

(Contract N00014-89-J-1545)

(AD-A258551; DU/DC/TR-32) Avail: CASI HC A02/MF A01

The 2:1 mole ratio reaction of InCl3 and P(SiMe3)3 in a toluene/THF mixture was investigated. Reaction appears to occur in a 1:1 mole fashion, since the products obtained are unreacted InCl3 (48.5 percent recovered) as InCl3(dot)2THF and a fine powder which roughly analyzes to be Cl2In3P3(SiMe3)2)(n). The latter was characterized by melting point and partial elemental analysis. The X-ray crystal structure of InCl3(dot)2THF is reported. InCl3(dot)2THF crystallizes in the orthorhombic space group Pbcn ((D(2h)(sup 14)), No.60) with unit cell parameters of a = 10.802(1) A, b = 10.101(1) A, c = 13.083(1) A, v = 1427.5(4) A3, and D(sub calcd) = 1.700 g/cu cm for Z = 4 (R = 0.042 (R(sub w) = 0.058)) and is an example of a neutral pentacoordinated bis-adduct of an indium(III) trihalide. The crystal structure consists of discrete monomeric units with no abnormally short intermolecular separations. The geometry about the indium atom approximates to trigonal bipyramidal with oxygen atoms of each of the THF molecules occupying axial positions In-O = 2.257(9) A, O-In-O = 178.5(3) deg while the three chlorine atoms (mean In-Cl = 2.321 A) lie in the equatorial plane. GRA

**N93-19957#** Pennsylvania State Univ., State College.

**SPACE CHARGE, HETEROJUNCTION AND ELASTIC STRESS EFFECTS IN FERROELECTRIC THIN FILMS Report, 1 Oct. 1991 - 30 Sep. 1992**

S. B. Krupanidhi 30 Sep. 1992 8 p

(Contract N00014-92-J-1912)

(AD-A258655) Avail: CASI HC A02/MF A01

The following scientific research goals are described: (1) inducing low energy ion bombardment related effects in ferroelectric thin films to enhance the oxygen incorporation efficiency; understanding space-charge related effects on polarization switching phenomena; understanding and correlation of the intrinsic multi-tunneling process across heterojunctions in ferroelectric thin films; establishing a correlation between low energy oxygen ion bombardment and space-charge and heterojunction based conduction and their impact on polarization switching; and correlation of switching mechanism via write voltage time dependence to the low energy induced property modifications. GRA

**N93-18479#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**MECHANISM OF DIAMOND FILM GROWTH**

L. R. Martin *In its* Aerospace Sponsored Research 1 Dec. 1991 p 69-70 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

**N93-18489#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**NANOTECHNOLOGY**

D. W. Pack and A. B. Pluchino *In its* Aerospace Sponsored Research 1 Dec. 1991 p 96-98 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

**N93-18490#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**SCANNING TUNNELING MICROSCOPE STUDIES OF NICKEL OXYHYDROXIDES**

A. H. Zimmerman and M. V. Quinzio *In its* Aerospace Sponsored Research 1 Dec. 1991 p 99-101 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

**N93-18493#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**STUDIES OF METAL-SEMICONDUCTOR CLUSTERS**

S. M. Beck *In its* Aerospace Sponsored Research 1 Dec. 1991 p 107-110 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-19720** Marmara Research Inst., Gebze (Turkey).
**ELEMENTS OF SCIENTIFIC RESEARCH: MODELING DISCOVERIES IN OXIDE SUPERCONDUCTIVITY**
Sakir Kocabas *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 63-70 (For primary document see N93-19711 06-82)
Copyright Avail: Issuing Activity

## 77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

**N93-19470#** Westinghouse Idaho Nuclear Co., Inc., Idaho Falls.
**VERIFICATION OF THERMODYNAMIC CODES REACT AND EQUILIB FOR THE STUDY OF NON-AQUEOUS INORGANIC SYSTEMS**
G. F. Kessinger Sep. 1992 44 p
(Contract DE-AC07-84ID-12435)
(DE93-001403; WINCO-1105) Avail: CASI HC A03/MF A01

This report is a description of studies performed to evaluate the performance of the Facility for the Analysis of Chemical Thermodynamics (F*A*C*T) EQUILIB and REACT computational package programs for applications involving the study of the chemical equilibria of non-aqueous inorganic systems. The REACT code was verified by comparing code results to the results of hand calculations; the EQUILIB code was verified by comparing code results to the results of hand calculations, published phase diagrams, and the results of the F*A*C*T REACT code (which was verified prior to its use to verify the EQUILIB code). The results of the verification tests identified two failures of the REACT code to compute reliable results and identifies the conditions when the quality of the computed results are affected. The verification tests for the EQUILIB code identified no failures of the code to produce reliable results. DOE

**N93-19489#** California Univ., Berkeley. Lawrence Berkeley Lab.
**DECOHERENCE OF MULTIMODE THERMAL SQUEEZED COHERENT STATES**
L. Yeh 14 Aug. 1992 15 p Presented at the Workshop on Harmonic Oscillators, Baltimore, MD, 25-28 Mar. 1992
(Contract DE-AC03-76SF-00098)
(DE93-002627; LBL-32101; CONF-9203181-2; UCB-PTH-92/07) Avail: CASI HC A03/MF A01

It is well known that any multimode positive definite quadratic Hamiltonian can be transformed into a hamiltonian of uncoupled harmonic oscillators. Based on this theorem, the multimode thermal squeezed coherent states are constructed in terms of density operators. Decoherence of multimode thermal squeezed coherent states is investigated via the characteristic function and it is shown that the decohered (reduced) states are still thermal squeezed coherent states in general. DOE

## 80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

**N93-18033*#** Alabama Univ., Tuscaloosa. Bureau of Engineering Research.
**THE 1992 NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM Final Administrative Report**
Oct. 1992 150 p
(Grant NGT-01-002-099)
(NASA-CR-191266; NAS 1.26:191266; BER-575-94) Avail: CASI HC A07/MF A02

This is the administrative report for the 1992 NASA/ASEE Summer Faculty Fellowship Program which was held at the George C. Marshall Space Flight Center (MSFC) for the 28th consecutive year. The nominal starting and finishing dates for the ten week program were June 1, 1992 through August 7, 1992. The program was sponsored by NASA Headquarters, Washington, D.C., and operated under the auspices of the American Society for Engineering Education (ASEE). The program was one of eight such programs at eight NASA centers sponsored and funded by NASA Headquarters. The basic objectives of the program are the following: (1) to further the professional knowledge of qualified engineering and science faculty members; (2) to stimulate an exchange of ideas between participants and NASA; (3) to enrich and refresh the research and teaching activities at the participants' institutions; and (4) to contribute to the research objectives of the NASA centers. The major activities of the 1992 program were the following: (1) recruitment, selection, and assignment of faculty fellows; (2) research performed by the participants in collaboration with the MSFC colleague; (3) a seminar and tour program aimed at providing information concerning activities at MSFC; (4) an activities program of a social/non-technical nature aimed at providing the fellows and their families a means of learning about the MSFC/Huntsville area; and (5) preparation of a volume containing the written reports of the details of the research performed by each of the summer faculty. The success of the 1992 program activities in meeting the stated objectives was measured through questionnaires, which were filled out by participants and their MSFC colleagues. The following sections describe the major activities in more detail and the results of the questionnaires are summarized showing that the 1992 program was highly successful. This year's program also included 19 participants in the Summer Teacher Enrichment Program (STEP) which is comprised of middle school and high school math and science teachers. Author

**N93-18358*#** National Aeronautics and Space Administration, Washington, DC.
**SPACE EDUCATION: DERIVING BENEFITS FROM INDUSTRIAL CONSORTIA**
Barbara A. Stone and John R. Page (New South Wales Univ., Kensington, Australia ) 1993 8 p Proposed for presentation at the Thirtieth Space Congress, Cocoa Beach, FL, 27-30 Apr. 1993
(NASA-TM-108593; NAS 1.15:108593) Avail: CASI HC A02/MF A01

As the number of spacefaring nations of the world increases, so does the difficulty of competing in a global economy. The development of high technology products and services for space programs, and the economic exploitation of these technologies for national economic growth, requires professionals versed in both technical and commercial aspects of space. Meeting this requirement academically presents two challenges. On the technical side, enrollment in science and engineering is decreasing in some of the spacefaring nations. From the commerce perspective, very few colleges and universities offer specific courses in space business. Author

**N93-18383#** National Science Foundation, Washington, DC. Directorate for Education and Human Resources.
**DECADE OF ACHIEVEMENT: EDUCATIONAL LEADERSHIP IN MATHEMATICS, SCIENCE AND ENGINEERING Activities Report, 1981-1991**
1991 35 p Original contains color illustrations
(NSF-92-94) Avail: CASI HC A03/MF A01

The effort to make the United States number one in math and science achievement must reflect the diversity of our country and our democratic approach to education. Everyone, not just a select few, must reap the benefits of our efforts to provide a world-class education to our students. There are many reasons for seeking to provide a world-class education. One reason is that education is important for its own sake. But education for its own sake is not as compelling an argument for government support as is the fact that a world-class education system is essential if we are to improve our standard of living and the quality of life on our planet. Described are the diverse and vigorous education and human resource programs the Foundation has developed and supported over the last ten years - activities that reach out to all, recognizing the needs of a changing U.S. population and a changing workplace. I.I.C.

**N93-18385*#** Auburn Univ., AL. Coll. of Sciences and Mathematics.
**THE 1992 SCIENCE OLYMPIAD NATIONAL TOURNAMENT Final Report**

W. D. Perry and Marllin L. Simon 27 Aug. 1992 133 p Tournament held 15-16 May 1992, Auburn, AL
(NASA Order H-07987-D)
(NASA-CR-191379; NAS 1.26:191379) Avail: CASI HC A07/MF A02

In the fall of 1991, approximately 8000 Junior and Senior High Schools from 39 states in the country registered one or more teams with the National Science Olympiad Headquarters, and started working their way towards the Science Olympiad National Tournament, which was held at Auburn University, Alabama on May 15 and 16, 1992. Teams that made it to the Science Olympiad National Tournament had to compete at the regional (e.g., Alabama had five regional tournaments) and state levels. In most cases a team had to be number one in the state in order to make it into the National Tournament. Since the decision was made to invite 50 teams from each division (division B is Junior High and division C is Senior High), for each state that did not participate, another state could send two teams. The selection of states that could send a second team was based on statewide registration with the National Headquarters. Author

**N93-19376#** Wichita State Univ., KS. National Inst. for Aviation Research.
**THE INTERNATIONAL FORUM ON AIRLINE QUALITY TEACHING GUIDE**
Dean E. Headley, ed., Brent D. Bowen, ed., and Sanda Moore, ed. Jul. 1992 74 p
(NIAR-92-13) Avail: CASI HC A04/MF A01

The International Forum on Airline Quality (IFAQ) Teaching Guide was created at the suggestion of the many people who recognized the potential for education inherent to the Forum proceedings. The purpose of the Guide, in addition to its primary function of reporting on the latest trends, debates, and general information, is to introduce students and professionals alike to the tremendous variety of issues regarding airline quality and the people who are at the forefront of innovation and change. The discussion questions at the end of each presentation were developed to assist the student in the clarification of the issues and to encourage thought that extends beyond the theories and arguments provided by the contributing authors. Some questions are deliberately open-ended; the student must thoroughly understand the issue and apply what has been learned in order to formulate an appropriate, reasonable response. The Teaching Guide may thus be used to test retention and comprehension. The Teacher's Edition includes a helpful key that supplies focus and specific examples where concrete answers are required; to this end, the key responses are direct quotations from each particular discourse. Author

**N93-19452*#** North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Mechanical Engineering.
**THE CENTER FOR AEROSPACE RESEARCH: A NASA CENTER OF EXCELLENCE AT NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY Annual Progress Report, 1 Jan. - 31 Dec. 1992**
Steven H.-Y. Lai 12 Dec. 1992 227 p Prepared for Futron Corp., Bethesda, MD
(Grant NAGw-2924)
(NASA-CR-191362; NAS 1.26:191362) Avail: CASI HC A11/MF A03

This report documents the efforts and outcomes of our research and educational programs at NASA-CORE in NCA&TSU. The goal of the center was to establish a quality aerospace research base and to develop an educational program to increase the participation of minority faculty and students in the areas of aerospace engineering. The major accomplishments of this center in the first year are summarized in terms of three different areas, namely, the center's research programs area, the center's educational programs area, and the center's management area. In the center's research programs area, we focus on developing capabilities needed to support the development of the aerospace plane and high speed civil transportation system technologies. In the educational programs area, we developed an aerospace engineering option program ready for university approval. For individual titles, see N93-19453 through N93-19466.

**N93-19453*#** North Carolina Agricultural and Technical State Univ., Greensboro. Structures Group.
**STRUCTURES RESEARCH** **c05**
Elias Abu-Saba, Williams McGinley, and Ji-Yao Shen *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 10 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

The main objective of the structures group is to provide quality aerospace research with the Center for Aerospace Research - A NASA Center for Excellence at North Carolina Agricultural and Technical State University. The group includes dedicated faculty and students who have a proven record in the area of structures, in particular space structures. The participating faculty developed accurate mathematical models and effective computational algorithms to characterize the flexibility parameters of joint dominated beam-truss structures. Both experimental and theoretical modelling has been applied to the dynamic mode shapes and mode frequencies for a large truss system. During the past few months, the above procedures has been applied to the hypersonic transport plane model. The plane structure has been modeled as a lumped mass system by Doctor Abu-Saba while Doctor Shen applied the transfer matrix method with a piecewise continuous Timoshenko tapered beam model. Results from both procedures compare favorably with those obtained using the finite element method. These two methods are more compact and require less computer time than the finite element method. The group intends to perform experiments on structural systems including the hypersonic plane model to verify the results from the theoretical models. Author

**N93-19454*#** North Carolina Agricultural and Technical State Univ., Greensboro. Controls and Guidance Group.
**CONTROLS AND GUIDANCE RESEARCH** **c08**
Abdollah Homaifar, DeRome Dunn, Yong-Duan Song, and Steven H.-Y. Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 16 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

The objectives of the control group are concentrated on research and education. The control problem of the hypersonic space vehicle represents an important and challenging issue in aerospace engineering. The work described in this report is part of our effort in developing advanced control strategies for such a system. In order to achieve the objectives stated in the NASA-CORE proposal, the tasks were divided among the group based upon their educational expertise. Within the educational component we are offering a Linear Systems and Control course for students in electrical and mechanical engineering. Also, we are proposing a new course in Digital Control Systems with a corresponding laboratory. Author

**N93-19455*#** North Carolina Agricultural and Technical State Univ., Greensboro. Computational Fluid Dynamics Group.
**COMPUTATIONAL FLUID DYNAMICS RESEARCH** **c34**
Suresh Chandra, Kenneth Jones, Hassan Hassan, and David Scott McRae *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 7 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

The focus of research in the computational fluid dynamics (CFD) area is two fold: (1) to develop new approaches for turbulence modeling so that high speed compressible flows can be studied for applications to entry and re-entry flows; and (2) to perform research to improve CFD algorithm accuracy and efficiency for high speed flows. Research activities, faculty and student participation, publications, and financial information are outlined. Author

**N93-19456*#** North Carolina Agricultural and Technical State Univ., Greensboro. Human-Machine Systems Engineering Group.
**FLIGHT SIMULATOR FOR HYPERSONIC VEHICLE AND A STUDY OF NASP HANDLING QUALITIES** **c09**
Celestine A. Ntuen, Eui H. Park, Joseph M. Deeb, and Jung H. Kim *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 8 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

The research goal of the Human-Machine Systems Engineering Group was to study the existing handling quality studies in aircraft with sonic to supersonic speeds and power in order to understand information requirements needed for a hypersonic vehicle flight simulator. This goal

falls within the NASA task statements: (1) develop flight simulator for hypersonic vehicle; (2) study NASP handling qualities; and (3) study effects of flexibility on handling qualities and on control system performance. Following the above statement of work, the group has developed three research strategies. These are: (1) to study existing handling quality studies and the associated aircraft and develop flight simulation data characterization; (2) to develop a profile for flight simulation data acquisition based on objective statement no. 1 above; and (3) to develop a simulator and an embedded expert system platform which can be used in handling quality experiments for hypersonic aircraft/flight simulation training. Author

**N93-19457*#** North Carolina Agricultural and Technical State Univ., Greensboro. Mechanical Engineering Dept.

**AEROSPACE ENGINEERING EDUCATIONAL PROGRAM**

William Craft, David Klett, and Steven Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 24 p (For primary document see N93-19452 06-80)

Avail: CASI HC A03/MF A03

The principle goal of the educational component of NASA CORE is the creation of aerospace engineering options in the mechanical engineering program at both the undergraduate and graduate levels. To accomplish this goal, a concerted effort during the past year has resulted in detailed plans for the initiation of aerospace options in both the BSME and MSME programs in the fall of 1993. All proposed new courses and the BSME aerospace option curriculum must undergo a lengthy approval process involving two cirriculum oversight committees (School of Engineering and University level) and three levels of general faculty approval. Assuming approval is obtained from all levels, the options will officially take effect in Fall '93. In anticipation of this, certain courses in the proposed curriculum are being offered during the current academic year under special topics headings so that current junior level students may graduate in May '94 under the BSME aerospace option. The proposed undergraduate aerospace option curriculum (along with the regular mechanical engineering curriculum for reference) is attached at the end of this report, and course outlines for the new courses are included in the appendix. Author

**N93-19458*#** North Carolina Agricultural and Technical State Univ., Greensboro. Controls and Guidance Group.

**DYNAMIC CHARACTERIZATION, MONITORING AND CONTROL OF ROTATING FLEXIBLE BEAM-MASS STRUCTURES VIA PIEZO-EMBEDDED TECHNIQUES** **c39**

Steven H.-Y. Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical StateUniversity 12 Dec. 1992 10 p (For primary document see N93-19452 06-80)

Avail: CASI HC A02/MF A03

A variational principle and a finite element discretization technique were used to derive the dynamic equations for a high speed rotating flexible beam-mass system embedded with piezo-electric materials. The dynamic equation thus obtained allows the development of finite element models which accommodate both the original structural element and the piezoelectric element. The solutions of finite element models provide system dynamics needed to design a sensing system. The characterization of gyroscopic effect and damping capacity of smart rotating devices are addressed. Several simulation examples are presented to validate the analytical solution. Author

**N93-19459*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**A PIECEWISE CONTINUOUS TIMOSHENKO BEAM MODEL FOR THE DYNAMIC ANALYSIS OF TAPERED BEAM-LIKE STRUCTURES** **c39**

Ji Yao Shen (North Carolina Agricultural and Technical State Univ., Greensboro.), Elias G. Abu-Saba (North Carolina Agricultural and Technical State Univ., Greensboro.), William M. McGinley (North Carolina Agricultural and Technical State Univ., Greensboro.), Lonnie Sharpe, Jr. (North Carolina Agricultural and Technical State Univ., Greensboro.), and Lawrence W. Taylor, Jr. *In* North Carolina Agricultural and Technical State Univ., The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 13 p Submitted for publication (For primary document see N93-19452 06-80)

Avail: CASI HC A03/MF A03

Distributed parameter modeling offers a viable alternative to the finite element approach for modeling large flexible space structures. The introduction of the transfer matrix method into the continuum modeling process provides a very useful tool to facilitate the distributed parameter model applied to some more complex configurations. A uniform Timoshenko beam model for the estimation of the dynamic properties of beam-like structures has given comparable results. But many aeronautical and aerospace structures are comprised of non-uniform sections or sectional properties, such as aircraft wings and satellite antennas. This paper proposes a piecewise continuous Timoshenko beam model which is used for the dynamic analysis of tapered beam-like structures. A tapered beam is divided into several segments of uniform beam elements. Instead of arbitrarily assumed shape functions used in finite element analysis, the closed-form solution of the Timoshenko beam equation is used. Application of the transfer matrix method relates all the elements as a whole. By corresponding boundary conditions and compatible conditions a characteristic equation for the global tapered beam has been developed, from which natural frequencies can be derived. A computer simulation is shown in this paper, and compared with the results obtained from the finite element analysis. While piecewise continuous Timoshenko beam model decreases the number of elements significantly; comparable results to the finite element method are obtained. Author

**N93-19460*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. Center for Aerospace Research.

**LUMPED MASS MODELLING FOR THE DYNAMIC ANALYSIS OF AIRCRAFT STRUCTURES** **c05**

Elias G. Abu-Saba (North Carolina Agricultural and Technical State Univ., Greensboro.), Ji Yao Shen (North Carolina Agricultural and Technical State Univ., Greensboro.), William M. McGinley (North Carolina Agricultural and Technical State Univ., Greensboro.), and Raymond C. Montgomery *In* North Carolina Agricultural and Technical State Univ., The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 10 p Submitted for publication (For primary document see N93-19452 06-80)

Avail: CASI HC A02/MF A03

Aircraft structures may be modelled by lumping the masses at particular strategic points and the flexibility or stiffness of the structure is obtained with reference to these points. Equivalent moments of inertia for the section at these positions are determined. The lumped masses are calculated based on the assumption that each point will represent the mass spread on one half of the space on each side. Then these parameters are used in the differential equation of motion and the eigen characteristics are determined. A comparison is made with results obtained by other established methods. The lumped mass approach in the dynamic analysis of complicated structures provides an easier means of predicting the dynamic characteristics of these structures. It involves less computer time and avoids computational errors that are inherent in the numerical solution of complicated systems. Author

**N93-19461*#** North Carolina Agricultural and Technical State Univ., Greensboro. Controls and Guidance Group.

**FULL DESIGN OF FUZZY CONTROLLERS USING GENETIC ALGORITHMS** **c61**

Abdollah Homaifar and Ed McCormick *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 12 p (For primary document see N93-19452 06-80)

Avail: CASI HC A03/MF A03

This paper examines the applicability of genetic algorithms (GA) in the complete design of fuzzy logic controllers. While GA has been used before in the development of rule sets or high performance membership functions, the interdependence between these two components dictates that they should be designed together simultaneously. GA is fully capable of creating complete fuzzy controllers given the equations of motion of the system, eliminating the need for human input in the design loop. We show the application of this new method to the development of a cart controller. Author

**N93-19462*#** North Carolina Agricultural and Technical State Univ., Greensboro.
**NONLINEAR ROBUST CONTROLLER DESIGN FOR MULTI-ROBOT SYSTEMS WITH UNKNOWN PAYLOADS** **c37**
Y. D. Song, J. N. Anderson (Tennessee Technological Univ., Cookeville.), A. Homaifar, and H. Y. Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 16 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

This work is concerned with the control problem of a multi-robot system handling a payload with unknown mass properties. Force constraints at the grasp points are considered. Robust control schemes are proposed that cope with the model uncertainty and achieve asymptotic path tracking. To deal with the force constraints, a strategy for optimally sharing the task is suggested. This strategy basically consists of two steps. The first detects the robots that need help and the second arranges that help. It is shown that the overall system is not only robust to uncertain payload parameters, but also satisfies the force constraints. Author

**N93-19463*#** North Carolina Agricultural and Technical State Univ., Greensboro.
**ROBUST MOTION TRACKING CONTROL OF ROBOTIC ARMS BASED ON THE GENERALIZED ENERGY ACCUMULATION PRINCIPLE** **c37**
Y. D. Song, J. N. Anderson (Tennessee Technological Univ., Cookeville.), A. Homaifar, and H. Y. Lai *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 8 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

Consider a rigid-link robot with the dynamic model tau = H(q;p)q'' + C(q,q',p)q' + G(q;p) + Nu(t) where Nu(.) denotes a bounded external disturbance. The objective addressed herein is to find a control strategy that exhibits the following features: (1) simple to implement, (2) easy to code for program, and (3) robust to possible time-varying uncertainties. Author

**N93-19464*#** North Carolina Agricultural and Technical State Univ., Greensboro. Human-Machine Systems Engineering Lab.
**MODELING HUMAN RESPONSE ERRORS IN SYNTHETIC FLIGHT SIMULATOR DOMAIN** **c54**
Celestine A. Ntuen *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 12 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

This paper presents a control theoretic approach to modeling human response errors (HRE) in the flight simulation domain. The human pilot is modeled as a supervisor of a highly automated system. The synthesis uses the theory of optimal control pilot modeling for integrating the pilot's observation error and the error due to the simulation model (experimental error). Methods for solving the HRE problem are suggested. Experimental verification of the models will be tested in a flight quality handling simulation. Author

**N93-19465*#** North Carolina Agricultural and Technical State Univ., Greensboro. Human-Machine Systems Engineering Lab.
**MODELING THE PERFORMANCE OF THE HUMAN (PILOT) INTERACTION IN A SYNTHETIC FLIGHT DOMAIN: INFORMATION THEORETIC APPROACH** **c54**
Celestine A. Ntuen *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 12 p (For primary document see N93-19452 06-80)
Avail: CASI HC A03/MF A03

Current advances in computing technology are devoid of formal methods that describe the theories of how information is shared between humans and machines. Specifically, in the domain of human-machine interaction, a common mathematical foundation is lacking. The aim of this paper is to propose a formal method of human-machine (H-M) interaction paradigm from the information view point. The methods presented are interpretation- and context-free and can be used both in experimental analysis as well as in modeling problems. Author

**N93-19466*#** North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Electrical Engineering.
**RECOGNITION OF PARTIALLY OCCLUDED THREAT OBJECTS USING THE ANNEALED HOPEFIELD NETWORK** **c54**
Jung H. Kim, Sung H. Yoon, Eui H. Park, and Celestine A. Ntuen *In its* The Center for Aerospace Research: A NASA Center of Excellence at North Carolina Agricultural and Technical State University 12 Dec. 1992 10 p (For primary document see N93-19452 06-80)
Avail: CASI HC A02/MF A03

Recognition of partially occluded objects has been an important issue to airport security because occlusion causes significant problems in identifying and locating objects during baggage inspection. The neural network approach is suitable for the problems in the sense that the inherent parallelism of neural networks pursues many hypotheses in parallel resulting in high computation rates. Moreover, they provide a greater degree of robustness or fault tolerance than conventional computers. The annealed Hopfield network which is derived from the mean field annealing (MFA) has been developed to find global solutions of a nonlinear system. In the study, it has been proven that the system temperature of MFA is equivalent to the gain of the sigmoid function of a Hopfield network. In our early work, we developed the hybrid Hopfield network (HHN) for fast and reliable matching. However, HHN doesn't guarantee global solutions and yields false matching under heavily occluded conditions because HHN is dependent on initial states by its nature. In this paper, we present the annealed Hopfield network (AHN) for occluded object matching problems. In AHN, the mean field theory is applied to the hybird Hopfield network in order to improve computational complexity of the annealed Hopfield network and provide reliable matching under heavily occluded conditions. AHN is slower than HHN. However, AHN provides near global solutions without initial restrictions and provides less false matching than HHN. In conclusion, a new algorithm based upon a neural network approach was developed to demonstrate the feasibility of the automated inspection of threat objects from x-ray images. The robustness of the algorithm is proved by identifying occluded target objects with large tolerance of their features. Author

**N93-18745#** Oulu Univ. (Finland). Dept. of Physics.
**EISCAT EDUCATIONAL PROGRAMS**
Jorma Kangas *In its* Report on the 7th Finnish EISCAT Workshop Feb. 1992 p 65-69 (For primary document see N93-18736 06-46)
Avail: CASI HC A01/MF A02

**N93-19405*#** University of Central Florida, Orlando. Dept. of Industrial Engineering and Management Systems.
**TRAINING EVALUATION FINAL REPORT**
Jose A. Sepulveda *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 451-458 (For primary document see N93-19390 06-99)
Avail: CASI HC A02/MF A06

**N93-19406*#** University of Central Florida, Orlando. Dept. of Industrial Engineering and Management Systems.
**NEEDS ASSESSMENT FINAL REPORT**
Jose A. Sepulveda *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 459-481 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

## 81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

**N93-17813#** Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France).
**DATA MODELIZATION FOR MANUFACTURING PLANNING AND SCHEDULING: AGGREGATION AND DISAGGREGATION MECHANISMS**
**Ph.D. Thesis - Inst. National des Sciences Appliquees de Toulouse**
Michel Aldanondo 1992 159 p In FRENCH
(LAAS-92263; ETN-93-93364) Avail: CASI HC A08/MF A02

Data modeling of manufacturing systems where the decision system is considered as a hierarchical set of decision centers is discussed. This modeling problem is frequently met while analyzing the management systems of industrial enterprises. Since the decision system is decomposed into decision levels, a data modeling framework corresponding to this decomposition is proposed. A generic model of the most detailed decision level is defined and rules ensuring data consistency are set. This basic model and these rules are used to study interactions between data models relevant to successive decision levels of a hierarchical stucture. Structural data is aggregated and decisional data is disaggregated. The 'horizontal' data consistency of each decision level and the 'vertical' consistency of data belonging to successive levels are analyzed. ESA

**N93-17862#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.

**AN ANALYSIS OF CONTRACT COST OVERRUNS AND THEIR IMPACTS M.S. Thesis**

Brian D. Wilson Sep. 1992 134 p

(AD-A258422; AFIT/GCA/LSY/92S-8) Avail: CASI HC A07/MF A02

This study examines the tendency of major program DoD contracts, once in an overrun status, to remain in that status and in many cases, further deteriorate. In these times of budgetary constraints, it is important that government program managers and other key decision makers understand the ramifications of contract overruns especially early in a program's life. The overruns on the A-12 program, for instance, could have possibly been predicted much earlier and the program cancellation avoided if only the program manager had understood the implications of significant cost overruns early in the life of the program. GRA

**N93-17916#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.

**CATEGORY SCALING WITHIN A GIVEN CONTEXT AS A COMMON BASIS FOR THE AHP, SMART AND ELECTRE**

F. A. Lootsma 1992 17 p

(Rept-92-22; ETN-93-93116) Copyright Avail: CASI HC A03/MF A01

Three methods for multicriteria decision analysis are addressed: the direct rating method in the Simple Multi-Attribute Rating Technique (SMART); the pairwise comparison methods in the Analytic Hierarchy Process (AHP); and the French set of ELECTRE systems. Since decisions are invariably made within a given context, relative preferences are modeled as ratios of increments or decrements in an interval on the axis of desirability. The ratio magnitudes are sorted into a small number of categories, represented by numerical values in a geometric scale. An explanation as to why AHP and ELECTRE are concerned with category judgement of ratio magnitudes, whereas SMART essentially uses the orders of mgnitude of these ratios, is given. This provides a common basis for the analysis of the methods in question and for a cross validation of their results. ESA

**N93-18087#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.

**APPLYING COMMERCIAL STYLE ACQUISITION PRACTICES TO THE PROCUREMENT OF COMMERCIALLY AVAILABLE AIRCRAFT M.S. Thesis**

Douglas W. Humerick and Steven H. Minnich Sep. 1992 192 p

(AD-A258143; AFIT/GCM/LSY/92-6) Avail: CASI HC A09/MF A02

This study was performed to recommend which commercial acquisition practices should be adopted in government acquisitions of commercially available aircraft. Previous studies, dating to 1972, illustrate the value of adopting commercial style acquisition practices in government acquisitions. Using commercial style acquisition practices can provide the government with lower costs and faster delivery with no sacrifice of quality. As a customer of the aircraft manufacturing community, the government must adapt to global market changes. Procedure reviews and changes must occur on an ongoing basis to take advantage of standard industry practices. Telephone interviews of nineteen top level personnel representing twelve domestic aircraft manufacturers revealed difficulties encountered in selling to the government: oversight and bureaucracy; payment practices; contract complexity; clause application; and MILSPEC's which go beyond FAA certification requirements. A qualitative analysis methodology was selected and recommendations for commercially available aircraft acquisitions include the following points: creating a separate regulation to govern use of commercial practices; using commercial payment practices; requiring cost benefit analysis for MILSPEC's and MILSTD's which exceed FAA certifications; removing CAS requirements; establishing a commercial advocate similar to the position of competition advocate; relying on commercial marker forces to ensure the manufacturers produce at a low cost and sell at a fair price; and empowering program managers and contracting officers to keep decisions at the lowest possible level to streamline the decision making process. GRA

**N93-18409#** Westinghouse Hanford Co., Richland, WA.

**MEETING THE CHALLENGE OF RESPONDING TO STAKEHOLDER INFORMATION NEEDS: A PROGRAM MODEL**

V. L. Birkland (Boeing Computer Services Co., Richland, WA.) Sep. 1992 5 p Presented at the Infotech 1992, Oak Ridge, TN, 21-23 Oct. 1992

(Contract DE-AC06-87RL-10930)

(DE93-002047; WHC-SA-1480; CONF-9210158-1) Avail: CASI HC A01/MF A01

In a dynamic, changing environment, effective decision-making is reached at the lower levels of an organization. With this concept in mind, Westinghouse Hanford Company designed a comprehensive information release program to manage information as close as possible to the original source. This paper describes that program and the issues associated with implementing its objectives: to improve the release process to respond to stakeholder requirements and liability for noncompliance. DOE

**N93-18439#** Office of Personnel Management, Washington, DC. Office of Executive and Management Policy.

**THE STATUS OF THE SENIOR EXECUTIVE SERVICE, 1991**

Sep. 1992 61 p Original contains color illustrations

(SES-92-07) Avail: CASI HC A04/MF A01

This document presents an overview of the administration, activities, and membership of the Federal Senior Executive Service (SES). Major employers, positions and appointments, and demographic characteristics of SES members are described. SES agenda items such as the enhancement of executive development programs, certification and performance appraisal, succession planning, and executive pay scales are addressed. The role and activities of the Office of Executive and Management Policy in administering the SES are discussed. Finally, the recipients of the Presidential Rank Awards are listed. M.G.

**N93-18888#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**GRAPHIC REPRESENTATION IN MANAGERIAL DECISION MAKING: THE EFFECT OF SCALE BREAK ON THE DEPENDENT AXIS M.S. Thesis**

Clark R. Carvalho and Michael D. McMillan Sep. 1992 118 p

(AD-A258989; AFIT/GSM/LSY/92S-5) Avail: CASI HC A06/MF A02

This thesis investigated whether a scale break on the dependent axis of a graph affects a decision maker's interpretation of the data presented in the graph. A literature search revealed criteria for constructing high integrity graphs and formatting scale breaks. An experiment was conducted to determine the effect of a scale break on the dependent axis. Graphs following the criteria for high integrity graphs were presented to the control group, while graphs following the criteria for high integrity graphs, with the exception of the scale break, were presented to the experimental group. Using a parametric two-sample t test and a non-parametric Rank Sum test, it was shown that data presented in a graph with a scale break was interpreted differently from data presented in a graph without a scale break. Analysis of variance was conducted on the demographic factors for each subject. In the experimental group, sex and professional experience were factors that led to different interpretations of graphs with a scale break. The level of experience using graphs in decision making was also a factor that led to different interpretations of graphs in both groups. GRA

**N93-19639#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

**CALENDAR OF SELECTED AERONAUTICAL AND SPACE MEETINGS, JULY 1991 ONWARDS [CALENDRIER DES MANIFESTATIONS AERONAUTIQUES ET SPATIALES (SELECTION) JUILLET 1991 ET AU-DELA]**

Jul. 1991 144 p

(AGARD-CAL-91/2; ISBN-92-835-0627-8) Copyright Avail: CASI HC A07/MF A02

The purpose of this AGARD publication is to assist members of the

Aeronautical and Space Community by: (1) informing them about many scheduled international scientific and technical meetings; and (2) avoiding the need for them to consult several sources in order to find out what meetings have been planned, their dates, and locations. The AGARD Calendar is published every six months, in June and December of each year. Details concerning the meetings listed in this particular issue of the calendar have been obtained from national and international organizations which sponsor aeronautical and space meetings and from other sources (journals, periodicals, etc.). Three kinds of events are covered by this calendar: (1) technical meetings, conferences, and symposia, held in all parts of the world, in the field of aerospace research and development as well as in other directly related scientific fields, such as energy, geophysics, and acoustics; (2) exhibitions and technical displays covering the same fields of interest; and (3) educational courses, short or long, given by certain specialized institutions. Author

**N93-19642#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**DISCUSSIONS ON THE ORGANIZATIONAL OUTLINE AND SUGGESTED INSTITUTIONAL GUIDELINES FOR THE INPE [DISCUSSOES SOBRE O PERFIL ORGANIZACIONAL E SUGESTOES DE DIRETRIZES INSTITUCIONAIS PARA O INPE]**

Sergio Alves Perilo, Paulo Tromboni Nascimento, and Rozane daFonsecaeSilva Apr. 1992 34 p In PORTUGESE Presented at the INPE's Special Strategic Planning Meeting held in Paulista, Brazil, Sep. 1991

(INPE-5406-RPQ/660) Avail: CASI HC A03/MF A01

This document was conceived chiefly with the purpose of instigating the discussion about what would be a suitable institutional model for the National Institute for Space Research (INPE) and which initiatives should be implemented in order to improve its performance. First, an analysis of the organizational profile and of the different kinds of activities being carried out at INPE is presented. In the sequence, some alternatives to better adjust its profile to this ensemble of activities are discussed. Finally, a new general objective and new general directives to INPE are proposed. Transl. by FLS

**N93-19844#** General Accounting Office, Washington, DC. Resources, Community, and Economic Development Div.

**UNIVERSITY RESEARCH: CONTROLLING INAPPROPRIATE ACCESS TO FEDERALLY FUNDED RESEARCH RESULTS. REPORT TO THE CHAIRMAN, HUMAN RESOURCES AND INTERGOVERNMENTAL RELATIONS SUBCOMMITTEE, COMMITTEE ON GOVERNMENT OPERATIONS, HOUSE OF REPRESENTATIVES**

4 May 1992 36 p

(GAO/RCED-92-104; B-247087) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

The Chairman, Human Resources and Intergovernmental Relations Subcommittee, House Committee on Government Operations, has expressed concern that closer links between universities and businesses have increased the potential for conflicts of interest that would give businesses inappropriate access to, and therefore an unfair advantage in commercializing, the results of federally funded research. To assess the extent of these linkages, the Chairman requested that we survey the universities receiving the most funding from NIH and NSF in fiscal year 1989 about: (1) the extent of licensing activities for technologies developed in whole or in part with NIH or NSF funding; (2) foreign participation in industrial liaison programs that, in return for membership fees, provide companies with access to research programs; and (3) policies and procedures to control potential conflicts of interest by faculty or administrators that could give companies inappropriate access to research results. As agreed with the Subcommittee, we assessed the overall relationship between universities and businesses without seeking to identify specific instances of inappropriate access. To obtain information about the extent of linkages between universities and businesses, we sent a questionnaire to 37 universities that were among the 25 leading university recipients of funding from NIH and/or the 25 leading university recipients of funding from NSF in fiscal year 1989. All of the universities, except the Baylor College of Medicine and the University of Pennsylvania, responded to the questionnaire. We also obtained additional data through telephone interviews with administrators at the 35 universities that responded. We did not independently verify the accuracy of data that the universities reported. Author

**N93-19938*#** National Aeronautics and Space Administration, Washington, DC.

**TOTAL QUALITY MANAGEMENT: IT WORKS FOR AEROSPACE INFORMATION SERVICES**

James Erwin, Carl Eberline, and Wanda Colquitt Jan. 1993 13 p Previously announced in IAA as A93-23312

(NASA-TM-108980; NAS 1.15:108980) Avail: CASI HC A03/MF A01

Today we are in the midst of information and 'total quality' revolutions. At the NASA STI Program's Center for AeroSpace Information (CASI), we are focused on using continuous improvements techniques to enrich today's services and products and to ensure that tomorrow's technology supports the TQM-based improvement of future STI program products and services. The Continuous Improvements Program at CASI is the foundation for Total Quality Management in products and services. The focus is customer-driven; its goal, to identify processes and procedures that can be improved and new technologies that can be integrated with the processes to gain efficiencies, provide effectiveness, and promote customer satisfaction. This Program seeks to establish quality through an iterative defect prevention approach that is based on the incorporation of standards and measurements into the processing cycle. Four projects are described that utilize cross-functional, problem-solving teams for identifying requirements and defining tasks and task standards, management participation, attention to critical processes, and measurable long-term goals. The implementation of these projects provides the customer with measurably improved access to information that is provided through several channels: the NASA STI Database, document requests for microfiche and hardcopy, and the Centralized Help Desk. Author

## 82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

**N93-17891#** TRW-Warner Robins, GA. Electronic Systems Group.

**TECHNICAL OPERATING REPORT ON THE DATA INTEGRATION AND COLLECTION ENVIRONMENT (DICE) INSTRUMENTATION SYSTEM DESIGN Interim Report, May 1991 - May 1992**

Jun. 1992 26 p

(Contract F04606-89-D-0040)

(AD-A258444; WL-TR-92-1068) Avail: CASI HC A03/MF A01

Current and planned avionics radar systems are highly sophisticated in their capabilities and heavily dependent on Embedded Computer Systems (ECS) for their operation. Avionics radar systems containing ECS provide a high level of flexibility in both system configuration and capability. However, increased flexibility requires increased logistical support. This support includes both hardware and software maintenance. Air Force Logistics Command (AFLC) is conducting a concentrated effort to limit the rising cost of ECS support while responding to user requests for improving these systems. This effort and the ECS Support Improvement Program (ESIP), a program implemented to address the problem of developing a rapid turnaround capability for airborne avionics radar systems, have as one of their research and development objectives to develop the necessary rapid turnaround capabilities to support mission critical ECS. Rapid Turnaround (RT) is defined as correcting a system deficiency in a timely fashion through some combination of software, firmware, and/or hardware modifications. The RT concept evolved from the overall AFLC objective to decrease the time and resources required to implement operational or maintenance changes in deployed ECS. Avionics systems are designed with internal data buses which can provide access to vast amounts of data. The data buses contain data, such as MIL-STD-1553 and H009, and are located primarily in the programmable signal processor. The need for an instrumentation system hosted on-board a tactical aircraft resulted in the development of the Data Integration and Collection Environment (DICE) System by TRW and the Air Force. GRA

**N93-17981#** Naval Postgraduate School, Monterey, CA.
**USING AN OBJECT-ORIENTED DATABASE MANAGEMENT SYSTEM TO ENHANCE THE REUSABILITY OF CLASS DEFINITIONS M.S. Thesis**
Tilemahos Poulis Sep. 1992 119 p
(AD-A257559) Avail: CASI HC A06/MF A02

One of the main benefits of object-orientation is reusability which allows modules (classes/objects) developed for a previous application to be used again for a new application. A Browser in object-oriented systems is a highly specialized system used in class libraries for viewing, writing, changing, and saving code. However, as the number of classes grows from the hundreds to the thousands to the tens of thousands, the Browser approach is not sufficient. The Class Storage and Retrieval System (CSRS) is a proposed system based on the Computer Aided Prototyping System that aims to overcome the insufficiencies of the Browser approach and, therefore, to enhance the reusability of classes in object-oriented systems. GRA

**N93-18013#** Air Univ., Maxwell AFB, AL.
**AIR UNIVERSITY LIBRARY INDEX TO MILITARY PERIODICALS, VOLUME 43, NUMBER 3, JULY - SEPTEMBER 1992**
Martha M. Stewart Sep. 1992 101 p
(AD-A258452) Avail: CASI HC A06/MF A02

The Air University Library to Military Periodicals is a subject index to significant articles, news items, and editorials appearing in 79 English language military and aeronautical periodicals. It originated with 23 titles as a quarterly publication in 1949 and has continued on a quarterly basis superseded by annual cumulations (triennial cumulative issues were published from 1952 through 1967). From 1949 to 1962 the Index was issued as Air University Periodical Index. Staff members of the Air University Library index all of the periodicals with the exception of seven titles which are indexed by other Air Forces, Army, Marine Corps, and Navy libraries. The Air University Library Index to Military Periodicals serves primarily the educations and reserach programs of Air University; it is available to other libraries upon request. GRA

**N93-18028#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**DEVELOPMENT OF A PROTOTYPE AIR FORCE INSTITUTE OF TECHNOLOGY (AFIT) RESEARCH MANAGEMENT SYSTEM (ARMS) M.S. Thesis**
David N. Schaaf and Carl W. Scott Dec. 1992 197 p
(AD-A258267; AFIT/GSS/LSC/92D-5) Avail: CASI HC A09/MF A03

The goal of this study was to design, develop, test, and evaluate an initial prototype information system to enhance the conduct and management of research in the School of Systems and Logistics at the Air Force Institute of Technology (AFIT). To accomplish this goal, the researchers developed and completed a methodology that was generally patterned after the milestones in a typical system development life cycle. The proof-of-concept nature of this research caused the researchers to also map the study's seven major objectives into a second system development model called the Spiral Model (Boehm, 1988:61). This hybrid approach provided better defined steps to a model that allows for iterative prototyping and served as the framework for this project. The prototype AFTT Research Management System (APRMS) produced by this study is comprised of subsystems that support research topic selection, research products reuse, research management, and database administration. An operational test of the system was completed and the results validated the desirability of the system concept and provided many recommendations for improving the ARMS. The recommendations for future research listed in Chapter 5 concern the follow-on development of the prototype and the conduct of important corollary studies. GRA

**N93-18075#** Societe Europeenne de Propulsion, Vernon (France).
**INCREASE OF OPERATIONAL RELIABILITY BY FEEDBACK EXPERIENCE/RETURN IN THE TECHNICAL AND INDUSTRIAL FIELD [LA CROISSANCE DE LA SURETE DE FONCTIONNEMENT PAR LE RETOUR D'EXPERIENCE DANS LE DOMAINE TECHNIQUE ET INDUSTRIEL]**
R. Vogin, G. Sciez, and J. C. Derbes 1992 7 p In FRENCH
Presented at Colloque Lambda-Mu, Grenoble, France, 6-8 Oct. 1992
(ETN-93-93014) Avail: CASI HC A02/MF A01

The compilation and exploitation of information gained from experience in technical and industrial domains, necessary in order to avoid repeating past errors, are discussed. The problem of passing on experience is addressed. The importance of collecting qualitative and quantitative information from both inside and outside a company is stressed. This information must include: source reference, technical description of the product (engine, type, thrust, etc.), problem observed, conditions in which it was seen, observed effect and potential, causes, and methods taken to reduce the risk. The construction of a data base, the standardization of data and its exploitation are addressed. ESA

**N93-18099#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**AN INFORMATION THEORETIC APPROACH TO DISTRIBUTED INFERENCE AND LEARNING Final Report, 1 Feb. 1990 - 31 May 1992**
Padhraic Smyth 1 Oct. 1992 35 p
(Contract N00014-92-J-1860; AF-AFOSR-0199-90; AF Proj. 7013)
(AD-A257935; AFOSR-92-0912TR) Avail: CASI HC A03/MF A01

This report describes research work which was funded under grant number AFOSR90-00199 during the period 1 Feb. 1990 - 31 May 1992. Our work has focused on developing information-theoretic and probabilistic models for neural network computation. This theoretical basis is then used to develop novel hybrid network architectures, which combine techniques from the fields of statistics and artificial intelligence with neural approaches. The report describes a number of significant results including the following: identification of the general class of energy functions which lead to proper probability estimation, a new algorithm which builds hybrid rule-based network models from data, Markov random field theory and algorithms for constructing network models from large databases, new results on sparse Markov models, a new hybrid unsupervised/supervised learning algorithm with applications to computer vision problems, a novel recurrent network structure, and prototype VLSI hardware implementations of these ideas. A total of 30 technical papers have resulted from this grant. GRA

**N93-18107#** Technische Univ., Berlin (Germany). Fachbereich Informatik.
**A MODEL FOR SECURITY AND DISTRIBUTION OF MANAGEMENT INFORMATION SYSTEMS Ph.D. Thesis [EIN MODELL FUER SICHERHEIT UND VERTEILTHEIT VON MANAGEMENTINFORMATIONSSYSTEMEN]**
Lutz Kleinholz 1992 187 p In GERMAN
(ETN-93-93029) Avail: CASI HC A09/MF A02

A model which integrates the aspects of safety and distribution for the special requirements of MIS (Management Information Systems) is presented. The model can be partially realized by the implementation of known mechanisms and architectures, although it is necessary to develop new formulations and processes in the safety area. The architecture model is designed to allow high parallelism capacities and availability of distributed MIS. Central and distributed data base management systems are combined in an homogeneous system by means of a distributed transaction processing and a communication model. The security is guaranteed by an authentification process and a flexible access control. Communication states of the distributed MIS are subdivided to reach to safety level of the server. A client-server model based on the concept of remote procedure calls is presented and examples are given and analyzed in terms of naming, heterogeneity, transparence, protection, and data exhange. The usability of semantic data control, object oriented design, and cyclic redundancy check is discussed and an implementation strategy of a prototype of the current model is described. ESA

**N93-18110*** National Aeronautics and Space Administration, Washington, DC.
**NASA PATENT ABSTRACTS BIBLIOGRAPHY: A CONTINUING BIBLIOGRAPHY. SECTION 1: ABSTRACTS (SUPPLEMENT 42)**
Jan. 1993 76 p
(NASA-SP-7039(42)-Sect-1; NAS 1.21:7039(42)-Sect-1) Avail: CASI HC A05

Abstracts are provided for 174 patents and patent applications entered into the NASA scientific and technical information system during the period July 1992 through December 1992. Each entry consists of a citation, an abstract, and in most cases, a key illustration selected from the patent or patent application. Author

**N93-18160*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**NASA/DOD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT: A COMPARISON OF THE TECHNICAL COMMUNICATIONS PRACTICES OF RUSSIAN AND US AEROSPACE ENGINEERS AND SCIENTISTS**

Thomas E. Pinelli, John M. Kennedy (Indiana Univ., Bloomington.), and Rebecca O. Barclay (Rensselaer Polytechnic Inst., Troy, NY.) Washington Jan. 1993 57 p

(RTOP 505-90-00)

(NASA-TM-107714; NAS 1.15:107714) Avail: CASI HC A04/MF A01

As part of Phase 4 of the NASA/DoD Aerospace Knowledge Diffusion Project, two studies were conducted that investigated the technical communications practices of Russian and U.S. aerospace engineers and scientists. Both studies have the same five objectives: first, to solicit the opinions of aerospace engineers and scientists regarding the importance of technical communications to their profession; second, to determine the use and production of technical communications by aerospace engineers and scientists; third, to seek their views about the appropriate content of an undergraduate course in technical communications; fourth, to determine aerospace engineers' and scientists' use of libraries, technical information centers, and on-line data bases; and fifth, to determine the use and importance of computer and information technology to them. A self-administered questionnaire was distributed to aerospace engineers and scientists at the Central Aero-Hydrodynamic Institute (TsAGI), NASA ARC, and NASA LaRC. The completion rates for the Russian and U.S. surveys were 64 and 61 percent, respectively. The responses of the Russian and U.S. participants, to selected questions, are presented in this report.

Author

**N93-18179#** Naval Postgraduate School, Monterey, CA.

**DESIGN AND IMPLEMENTATION OF A GRAPHICAL USER INTERFACE FOR A MULTIMEDIA DATABASE MANAGEMENT SYSTEM M.S. Thesis**

Metin Balci and Erhan Saridogan Sep. 1992 136 p

(AD-A257577) Avail: CASI HC A07/MF A02

The purpose of this thesis was to design and implement a graphical user interface for a multimedia database management system prototype previously implemented at the Naval Postgraduate School. Because of complexity of data types and difficulty of manipulating them, it was very hard for a casual user to use the previous system. Since graphical interaction simplifies control dialogue, we designed and implemented a graphical user interface using C++ and InterViews 3.0.1 for a Sun-3 workstation under Unix X-Windows environment with mouse support. We then connected this interface to the multimedia database system prototype. Our interface supports incremental query specification using extended SQL and can be connected to database applications in several different ways. An embedded global data structure, a text file or character string can be used for connections. A second version of the interface for a Sun-4 workstation was built and connected to another database system using the character string and text file. This version demonstrated even better performance.

GRA

**N93-18231#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**NAVIGATION OF AVHRR/NOAA IMAGES: OPERATIONAL PROCEDURE FOR SUN WORKSTATION [LEITURA E NAVEGACAO DE IMAGENS AVHRR/NOAA: PROCEDIMENTO OPERACIONAL PARA UTILIZACAO ATRAVES DA ESTACAO DE TRABALHO SUN]**

Keiko Tanaka, Andre Luiz MouradosSantos, and Joao RobertodosSantos Aug. 1991 63 p In PORTUGESE

(INPE-5354-RPQ/654) Avail: CASI HC A04/MF A01

A brief outline of the steps of the operational procedure of preprocessing of the Advanced Very High Resolution Radiometer (AVHRR) images obtained from the NOAA-9, NOAA-10, and NOAA-11 polar orbit satellites, using the SPARC SERVER 390 - SUN workstation is presented. It describes, in detail, the mathematical algorithm and the application program manual to preprocess the AVHRR data. Also, the computer code (in C language) is available for transforming the original raw data into a more feasible form of direct access for the image processing system; displaying and visualizing the images; and transforming the image coordinates (row and column) into geographical coordinates (latitude and longitude). This procedure is an important stage to provide the AVHRR data users an operational mode, generating products such as vegetation index mosaics which are useful for vegetation cover studies.

Author

**N93-18307#** Naval Postgraduate School, Monterey, CA.

**DATA MANAGEMENT: IMPLEMENTATION AND LESSONS LEARNED FROM DEPARTMENT OF THE ARMY DATA MANAGEMENT PROGRAM M.S. Thesis**

Christine M. Donohue and Gregory A. Hayes Sep. 1992 86 p

(AD-A257858) Avail: CASI HC A05/MF A01

Information systems executives within the Department of Defense (DoD) are being challenged to develop innovative ways in which information technology can contribute to the streamlining of DoD organizations. A key step in developing information systems that will meet the future needs of DoD organizations is to manage the data resource. This thesis examines the concepts, implementation strategies, and issues relating to data management and illustrates, using a case study of the Department of the Army data management methodology, the critical success factors required to implement data management programs throughout the DoD.

GRA

**N93-18337#** Naval Postgraduate School, Monterey, CA.

**THE OBSTACLES ENCOUNTERED IN THE DEVELOPMENT OF SMMS: A CASE STUDY M.S. Thesis**

David G. Broadwater Jun. 1992 81 p

(AD-A257880) Avail: CASI HC A05/MF A01

Automated data processing for non-tactical applications afloat was first implemented on large platforms with the SNAP 1 system. This system provided excellent inventory management and financial and accounting service in the punch card and magnetic tape environment in which it was introduced. Subsequent modifications have been made to take advantage of changing technologies and increased user expectations. Automated data processing on smaller platforms was implemented with the SNAP 2 program. While serving many of the same functions this implementation was designed separately and for a different user group. The SMMS program discussed here in a case format was an attempt to consolidate and enhance the two SNAP programs.

GRA

**N93-18344#** Naval Postgraduate School, Monterey, CA.

**IMPLEMENTATION OF A CONFIGURATION AND MAINTENANCE MANAGEMENT SYSTEM FOR LOCAL AREA NETWORKS M.S. Thesis**

David G. Dickison Sep. 1992 151 p

(AD-A257837) Avail: CASI HC A08/MF A02

The management of Local Area Networks today is one of the most challenging tasks which face a system manager. The plethora of system software, application software and accessories available combined with the various computer clones, and open architecture present in microcomputers makes tracking Local Area Network configuration and maintenance a very daunting task. This thesis modifies a previous design for a Local Area Network configuration and maintenance database and implements the new design in Dbase 4 version 1.1 using the Naval Postgraduate School Administrative Science Department Local Area Networks as a prototype database. The database was designed to be simple to use, to protect data integrity and to be expandable to new equipment, new technology and new data applications. Due to its general nature, the Local Area Network Maintenance and Configuration System can be used on virtually any Local Area Network application.

GRA

**N93-18410*** National Aeronautics and Space Administration, Washington, DC.

**NASA PATENT ABSTRACTS BIBLIOGRAPHY: A CONTINUING BIBLIOGRAPHY. SECTION 2: INDEXES (SUPPLEMENT 42)**

Jan. 1993 592 p

(NASA-SP-7039(42)-Sect-2; NAS 1.21:7039(42)-Sect-2) Avail: CASI HC A25

A subject index is provided for over 4900 patents and patent applications for the period May 1969 through December 1992. Additional indexes list personal authors, corporate authors, contract numbers, NASA case numbers, U.S. patent class numbers, U.S. patent numbers, and NASA accession numbers.

Author

**N93-18445#** Universiteit Twente, Enschede (Netherlands).
**THE INTEGRATION OF SPECIFICATION ASPECTS IN DATABASE DESIGN Ph.D. Thesis**
Rudolphus Antonius deBy 1991 219 p
(ISBN-90-9004461-2; ETN-92-92827) Copyright Avail: CASI HC A10/MF A03

The conceptual design of databases is discussed. An investigation into the possibilities of exploiting already specified parts of a database to deduce specifications of the parts is presented. The objective is to obtain a design process that is both efficient and integrated. Three sublanguages which can be used in the design processs are defined. The basic semantic data model is introduced as a sublanguage with which data structure can be specified. The possibilities of using already obtained partial specifications is studied. It turns out that the use of partial specifications from the first design step is mainly of a direct verifying nature, or a type checking nature. Repair actions themselves are taken, as the sources for update propagation. The conclusion is that an integrated approach of conceptual database design is feasible. ESA

**N93-18526#** Oak Ridge National Lab., TN.
**DATA MANAGEMENT PLAN FOR THE OAK RIDGE ENVIRONMENTAL INFORMATION SYSTEM, VERSION 1.1**
Aug. 1992 152 p
(Contract DE-AC05-84OR-21400)
(DE92-041219; ES/ER/TM-39) Avail: CASI HC A08/MF A02

The Data Management Plan (DMP) describes the data management objectives, system components, data base structure and contents, system maintenance, data processing, and user interface for the prototype phase of the Oak Ridge Environmental Information System (OREIS). The major goals of OREIS data management are to compile data of known quality, to maintain the integrity of the data base, and to provide data to users. The DMP defines the requirements, describes the responsibilities, and references the procedures for meeting the data management objectives. Emphasis is on management of measurement data and the associated metadata used to support its proper interpretation and legal defensibility. The DMP covers transmittal, processing, storage, and data access activities associated with OREIS. The OREIS data dictionary is provided as an appendix. DOE

**N93-18977#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**IMPROVING THE QUALITY OF MACHINE TRANSLATIONS BY PROVIDING STYLISTIC GUIDELINES TO AUTHORS AND EDITORS M.S. Thesis**
Edward J. Walsh Dec. 1992 154 p
(AD-A258786; AFIT/GIR/DEM/92D-9) Avail: CASI HC A08/MF A02

This research sought to identify stylistic guidelines which could be used by the authors and editors of English language texts in order to improve the quality of subsequent machine translations to other languages. A literature review was conducted to provide background information and to determine what guidelines would be appropriate. Nine guidelines were developed on the basis of the review. The guidelines were then tested. They were applied to five paragraphs from a Royal Australian Air Force technical publication by the researcher and an independent volunteer. Both the resulting texts and the original paragraphs were translated into French using the Globalink Translation System and the quality of the translations obtained was evaluated by four human translators. While the translations of the paragraphs which had been edited by the volunteer were significantly better than the translations of the original texts, the translations of the paragraphs edited by the researcher were not. Use of the guidelines by authors and editors cannot be recommended on the basis of this result. However, analysis of the conduct and results of the research suggested potentially fruitful alternative approaches to the development and testing of guidelines. These approaches are presented as specific recommendations for further research. GRA

**N93-19017#** Defense Technical Information Center, Alexandria, VA.
**DROLS WORKBOOK Final Report**
Christian M. Cupp, Keith L. Thompson, Richard J. Wayman, Karen V. Fox, and Charles E. Reed Jan. 1993 54 p Supersedes DTIC/TR-92-4 dated Jan. 1992, AD-A255850 (AD-A259033; DTIC/TR-93-8; DTIC/TR-92-4) Avail: CASI HC A04/MF A01

This Workbook provides practical exercises to assist users in learning the Defense RDT and E Online System (DROLS). It is intended to be used in conjunction with DTICH 4185.4, DROLS Handbook. Basic and advanced search exercises are provided to assist the user in creating the best strategy for getting the desired results. Answers to exercises and problem sets are in Appendix 3. GRA

**N93-19063#** Naval Postgraduate School, Monterey, CA. Dept. of Administrative Sciences.
**DATA MANAGEMENT: IMPLEMENTATION AND LESSONS LEARNED FROM THE DEPARTMENT OF THE ARMY DATA MANAGEMENT PROGRAM**
Tung X. Bui, Daniel R. Dolk, Christine M. Donohue, and Gregory A. Hayes Sep. 1992 78 p
(Contract MIPR-DXAM20001)
(AD-A258796; NPS-AS-93-004) Avail: CASI HC A05/MF A01

This study reports the lessons learned from the Department of the Army effort to identify and standardize data so that they can be shared across functional boundaries. Among other findings, this report concludes that data management is a continual process, and its success requires time and resources and an effective communication between those who make the data management policy and those who implement that policy. GRA

**N93-19074#** South Carolina Research Authority. Charleston.
**PDES APPLICATION PROTOCOL SUITE FOR COMPOSITE (PAS-C) SCOPING AND BENEFITS CRITERIA. VOLUME 1: EXECUTIVE SUMMARY AND OVERVIEW Final Report, 15 Jul. 1991 - 15 Apr. 1992**
Greg Paul, Dennis Biddle, Jon Judd, Keith Hunten, and Floyd Ganus May 1992 44 p
(Contract F33615-91-C-5713)
(AD-A258833; PASC007-01-00; WL-TR-92-8063) Avail: CASI HC A03/MF A01

This document is part of a two volume set that explains the methodology and results of the PAS-C program's scoping and benefits analysis. Volume 1 (PASC007.01.00) is an over-view of the PAS-C program. The results of the Program's efforts to date relative to scoping the PAS-C application protocol suite, a summary of the benefits that could be realized on the PAS-C demonstration parts, and a summary of the program's success criteria. Volume 2 (PASC008.01.00) gives the details of the data that is presented in Volume 1. GRA

**N93-19084#** General Accounting Office, Washington, DC. National Security and International Affairs Div.
**INFORMATION TECHNOLOGY: COMMENTS ON NAVY FACILITY CONSOLIDATION PLAN**
3 Dec. 1992 9 p
(AD-A258964; GAO/NSIAD-93-87) Avail: CASI HC A02/MF A01

On 24 Jul. 1992, the Under Secretary of the Navy submitted for our review his department's Information Technology Facility (ITF) consolidation plan of 1 Jun. 1992. Under the fiscal year 1992 Department of Defense (DOD) appropriations act (sec. 8049), neither DOD nor the Navy may obligate or expend funds to implement a plan affecting ITF's in New Orleans, Louisiana, until 60 days after you submit a report, including our review comments, to the House and Senate Committees on Appropriations. In your report, you are required to address the Navy's needs for information technology support and certify that the proposed consolidation plan will not duplicate any function presently conducted; will be cost effective from a budgetary standpoint; and will not adversely affect the mission, readiness, and strategic considerations of the Navy and Naval Reserve. GRA

**N93-19098#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**CORPORATE INFORMATION MANAGEMENT AND BUSINESS PROCESS IMPROVEMENT UNDER THE UNIT COST PROGRAM: AN ANALYSIS OF A SYSTEM FOR THE AIR FORCE INSTITUTE OF TECHNOLOGY M.S. Thesis**
Kevin D. Kettell and Fredrick T. Ziegler, II Dec. 1992 374 p
(AD-A258984; AFIT/GIR/LSP/92D-7) Avail: CASI HC A16/MF A03

DOD has been undergoing changes toward a competitive business-type environment as a result of the Packard Commission and the

Goldwater-Nichols Act. As a result of the Goldwater-Nichols Act, two programs directly affect the Air Force Institute of Technology (AFIT): Defense Management Report Decision 971, better known as the Defense Business Operations Fund (DBOF); and, the Corporate Information Management (CIM) initiative. DBOF requires that organizations provide unit cost per output figures as the basis for organizational funding. Unit cost resourcing changes the way federal managers manage and allocate resources, and promotes quality management and continuous improvement principles. Defense Information Management recognizes information as a resource to be managed. CIM initiatives use information as the basis to improve the way organizations operate. This research effort purports to identify strategic level requirements that will allow the establishment of an integrated information system which will provide AFIT insight into the cost and value of their products and services. GRA

**N93-19451#** Army Training and Doctrine Command, Fort Monroe, VA.
**TRADOC LIBRARY AND INFORMATION NETWORK (TRALINET). UNION LIST OF PERIODICALS (TULIP) Final Report**
Edwin B. Burgess, Ron Novy, and Sharon Alsip 1 Oct. 1992 . 556 p Supersedes 4th Edition, AD-A236575, dated 1 Oct. 1990
(AD-A258935) Avail: CASI HC A24/MF A04

This is the fifth edition of the TRADOC Library and Information Network (TRALINET) union list of periodicals. It is a composite of the fourth edition and all changes submitted by TRADOC libraries. GRA

**N93-19644#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**INCORPORATION OF ORBITAL IMAGERY INTO A CARTOGRAPHIC DATA BASE [INTEGRACAO DE IMAGENS ORBITAIS A UMA BASE DE DADOS CARTOGRAFICOS]**
Fernando Augusto Mitsuo, II, Julio Cesar Lima DAlge, Ricardo Cartaxo Mode deSouza, and Virginia Ragoni deMoraesCorreia Oct. 1991 8 p In PORTUGESE
(INPE-5300-PRE/1705) Avail: CASI HC A02/MF A01

Matching between orbital imagery and cartographic data bases requires a geocoding procedure, which comprises the geometric correction of the images in order to link them to the projection of the data base. This work presents the importance of geocoding and describes the methodology used at INPE, considering some important cartographic projection systems and both images of high (remote sensing satellites) and low (meteorological satellites) spatial resolutions. Transl. by FLS

**N93-19711** Wichita State Univ., KS. National Inst. for Aviation Research.
**PROCEEDINGS OF THE ML-92 WORKSHOP ON MACHINE DISCOVERY (MD-92)**
Jan M. Zytkow, ed. Jul. 1992 179 p Workshop held in Aberdeen, Scotland, 4 Jul. 1992
(NIAR-92-12) Copyright Avail: Issuing Activity

Machine Discovery (MD) originated arguably in the late 1970s, and grew steadily throughout the 1980s. In recent years, MD has seen significant expansions, which may be contributed to the belief that machine discovery systems can offer practical solutions in large scale data exploration, satisfying a definite and critical need for automation. Traditionally, the main focus in MD has been on scientific discovery. In the last four years, however, a new area of knowledge discovery in databases has been established, focusing on practical problems of search for knowledge in databases and fueled by enormous sizes of existing and expected databases. Papers on the following topics from the workshop are presented: knowledge discovery in databases; scientific discovery; concept discovery; automated data analysis; exploration environment; discovery of mathematics; and evaluation of machine discovery systems. For individual titles, see N93-19712 through N93-19736.

**N93-19712** German National Research Center for Computer Science, Washington, DC.
**PATTERNS FOR KNOWLEDGE DISCOVERY IN DATABASES**
Willi Kloesgen *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 1-10 (For primary document see N93-19711 06-82)
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We describe a typology of some patterns which are useful for knowledge discovery in databases (KDD). At first, the requirements of KDD are treated, referring to the main terms of a KDD definition which are nontrivial extraction, high-level presentation, and interesting information. Then we collect some distinguishing features of patterns as a base to develop a typology of patterns. The main dimensions of a typology for dependency patterns are the number of subpopulations compared in a pattern, type of variables, deterministic or probabilistic verification methods, the number of dependent variables integrated within a pattern, and the kind of language used to form subgroups, target groups, and subpopulations. According to this typology, patterns are described in more detail. This paper concludes with a general discussion of search strategies that work on spaces of hypotheses to discover instances of patterns. Author

**N93-19713** GTE Labs., Inc., Waltham, MA.
**PROBABILISTIC DATA DEPENDENCIES**
Gregory Piatetsky-Shapiro *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 11-17 (For primary document see N93-19711 06-82)
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Knowing inter-field dependencies is important for understanding the data and has many applications in analyzing databases. I analyze several measures of dependencies between nominal field values and give examples of how dependency graphs can be useful for interpreting changes in data. I show how to determine the significance of dependency using the randomization approach and present an experimentally supported simple formula for determining the expected value of a dependency measure. I also outline a way to extend dependency analysis to relationships among individual field values. Author

**N93-19714** Wichita State Univ., KS. Dept. of Computer Science.
**DISCOVERY OF REGULARITIES IN DATABASES**
Robert Zembowicz and Jan M. Zytkow *In its* Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 18-27 (For primary document see N93-19711 06-82)
(Contracts N00014-88-K-0226; N00014-90-J-1603)
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Large databases, common in typical business, educational, health-related, scientific, or engineering enterprises, can be a source of useful knowledge. Yet this knowledge is only implicit in the data. It must be mined and expressed in a concise, useful form of statistical patterns, equations, rules, conceptual hierarchies, and the like. Automation of knowledge mining is important because databases are very large, numerous, and rapidly growing. We present Forty-Niner (49er), a general-purpose database mining system, which conducts a large-scale search for useful knowledge. We define a regularity, which is the basic form of knowledge discovered by 49er. The 49er searches for regularities in the form of statistical patterns and equations, conducting a more costly search for equations only when data indicate a functional relationship between variables. The 49er combines several searches, each contributing to different aspect of regularity. Correspondence between the search components and the components of knowledge makes the system easy to understand, use, and expand. Regularities can be further refined by 49er, typically yielding much stronger regularities and useful concepts. Finally, we discuss 49er's performance in four categories of tests. First, we applied 49er to large databases. Search in a megabyte-size database typically yields many regularities, but it would take human experts weeks to verify the optimality of 49er's results. The second type of testing aims at reproduction of human findings. Databases which have been extensively studied are rare, however. To evaluate 49er on large scale against known results, we use hide-and-seek testing on artificially created data. In the fourth approach, we analyze discovery of regularities in randomly generated databases.
Author

**N93-19715** Polish Academy of Sciences, Warsaw. Inst. of Computer Science.
**EXTRACTING KNOWLEDGE FROM DATA: SYS8688 APPROACH**
Mieczyslaw A. Klopotek, Andrzej Matuszewski, and Maciej Michalewicz *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 28-34 (For primary document see N93-19711 06-82)
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The necessity of verification of expert knowledge, especially that

contained in knowledge bases, against real life data is widely recognized, however, in case of uncertainty modeling via MYCIN-like Certainty Factors such a procedure is hard to operationalize due to missing probabilistic interpretation. Only approximate solutions are possible in general. The paper describes and justifies our approach to this task based on the defendable assumption, that all the strong independence assumptions implied by the CF-model will hold true if rule probabilities are high. The paper points at a close relationship between several probabilistic CF interpretations with Pearson's r correlation coefficient being the starting point of our statistical knowledge acquisition strategy. Author

**N93-19716** Nippon Electric Co. Ltd., Kawasaki (Japan). C and C Systems Research Labs.

**LARGE-SCALE INDUCTION OF RIPPLE-DOWN-RULES: SOME PRELIMINARY CONSIDERATIONS**

Jason Catlett *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 35-40 (For primary document see N93-19711 06-82)

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This paper first summarizes work from two previous papers: a case study of rule induction on a very large dataset concerning the Space Shuttle, and an argument that ripple-down-rules (RDR's) may be a better knowledge representation for large scale induction than ordered rules. It then uses the Shuttle example to illustrate some potential difficulties faced in the induction of RDR's, and sketches some possible solutions. Author

**N93-19717** Aberdeen Univ. (Scotland). Dept. of Computing Science.

**SELF-QUESTIONING AND EXPERIMENTATION IN AN EXPLORATORY DISCOVERY SYSTEM**

Ruediger Oehlmann, Derek Sleeman, and Peter Edwards *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 41-50 (For primary document see N93-19711 06-82)

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In contrast to experimental scientists, current discovery systems very rarely make use of previous experience. Furthermore, these systems do not employ strategies which support the controlled exploration of different options for experimentation. In our implementation, IULIAN, we overcome these limitations by an integration of self-questioning, experimentation, and self-answering, all implemented as case-based planners. We refer to this integrated approach as exploratory discovery, because it enables the system to investigate optional experiments as well as optional methods of reasoning. In particular, it is the interaction between Self-Questioning and Experimentation that accounts for additional plan modifications. In order to explain the overall architecture representing an integration of aspects of machine discovery and case-based reasoning, we use an example addressing the revision of a casual model in the domain of electrical circuits. After describing the generation of questions, answers, and experiments as case-based planning tasks, we argue for a tight interaction between self-questioning and experimentation to facilitate additional modifications of question and experimentation plans. These modifications enable the system to learn how to improve its methods for revising its underlying casual model rather than merely learning a revised model. Author

**N93-19718** Carnegie-Mellon Univ., Pittsburgh, PA. School of Computer Science.

**DISCOVERY OF PATHWAYS IN SCIENCE**

Raul E. Valdes-Perez, Herbert A. Simon, and Robert F. Murphy *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 51-57 (For primary document see N93-19711 06-82)

(Grant NSF DIR-89-20118)

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Pathway discovery is a generic task in science. Analogous instances of it can be drawn from the domains of chemistry, cognitive psychology, cellular biology, and genealogy, despite the apparent dissimilarity of these domains. Except for genealogy, computer systems have been built to automate partially each of these pathway-discovery tasks. The MECHEM system dealing with chemical reaction pathways is a current instance. We are working on a general account of pathway discovery in science that provides a conceptual base for systematic analyses of suitable search algorithms. This paper identifies the pathway-discovery task, contributes a definition of pathway and a hierarchical analysis of pathway processes, shows how search proceeds across hierarchical levels in different domains, and examines how domain knowledge constrains plausibility. The four domains above are discussed in some detail. Author

**N93-19719** California State Univ., Hayward.

**MACHINE DISCOVERY APPROACH TO DYNAMIC SYSTEMS IN THE REAL LABORATORY**

Marek W. Bielecki *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 58-62 (For primary document see N93-19711 06-82)

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This paper argues that the application of machine discovery (MD) methods can help in modeling complex dynamic systems, the systems that have recently become an object of intensive scientific study in terms of chaos theory. MD research itself can also benefit from shifting its focus from artificial models to actual scientific systems. The paper outlines the architecture for an MD system designed to serve as an 'intelligent scientist's assistant' (ISA) in the domain of dynamic systems. It involves three major modules: the Data Analyzer, the Model Generator, and the Model Evaluator. Their interactions are intended to simulate a recursive process of data analyzing and model building that is characteristic of the actual scientific activity. The Data Analyzer discovers regularities in empirical data. The Model Generator postulates differential equations that describe the system's dynamics. The Model Evaluator compares the experimentally obtained data with the numeric data generated from the equations, requests new data, and postulates changes to the parameters and initial conditions of the dynamic system. The discovery system halts when a desired level of compatibility between the numeric and experimental data is achieved. All modules may combine geometric and symbolic reasoning processes and utilize both domain-specific and domain-independent knowledge. The paper points out similarities and differences between the systems such as KAM and FAHRENHEIT and the corresponding modules of ISA. Author

**N93-19720** Marmara Research Inst., Gebze (Turkey).

**ELEMENTS OF SCIENTIFIC RESEARCH: MODELING DISCOVERIES IN OXIDE SUPERCONDUCTIVITY** **c76**

Sakir Kocabas *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 63-70 (For primary document see N93-19711 06-82)

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We describe a program, CER, which models the research tasks carried out in the process of the discovery of high-temperature superconductors in 1986 and 1987. The program simulates some of these research tasks through the activities of its autonomous operators. Each of these operators carries out a research task, applying several different learning methods at three different levels. In its knowledge organization and control of research tasks, CER constitutes a step towards developing a more comprehensive model of scientific research. The paper describes the system in terms of its knowledge representation and learning and discovery methods; examines its merits and shortcomings; and provides ideas for its improvement. Author

**N93-19721** Oregon State Univ., Corvallis. Dept. of Computer Science.

**TOWARD MODEL-BASED DISCOVERY: A CASE STUDY IN ECOSYSTEM PREDICTION**

Thomas G. Dietterich *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 71-76 (For primary document see N93-19711 06-82)

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Machine discovery has often been idealized as the discovery of new phenomena in the absence of any prior knowledge. Knowledge-free discovery is not the norm in science, however. A central challenge for machine discovery is to develop techniques that combine prior knowledge with data to discover knowledge that is beyond the reach of traditional methods that rely only on data and weak prior biases. A critical task is to develop representations that capture prior knowledge while also supporting efficient discovery algorithms. In this paper, we present such a representation and propose a discovery algorithm that operates on this representation. The representation is intended to capture and refine simple models of plant physiology and apply these models to predict the consequences of global warming on the geographical distribution of plant ecosystems. Author

**N93-19722** Georgia Inst. of Tech., Atlanta. Coll. of Computing.
**DISCOVERY OF PHYSICAL PRINCIPLES FROM DESIGN EXPERIENCES**
Sambasiva R. Bhatta and Ashok K. Goel *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 77-81 (For primary document see N93-19711 06-82)
(Contract N00014-92-J-1234; NSF CCR-86-19886)
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One method for making analogies is to access and instantiate abstract domain principles, and one for acquiring knowledge of abstract principles is to discover them from experience. We view the task of hypothesis formation, a subtask of discovery, as generalization over experiences in the absence of any prior knowledge of the target principle. In this paper, we focus on discovery of physical principles by generalization over design experiences in the domain of physical devices. Some important issues in generalization from experiences are what to generalize from an experience, how far to generalize, and what methods to use. We represent a reasoner's comprehension of specific designs in the form of structure-behavior-function (SBF) models. An SBF model provides a functional and casual explanation of the working of a device. We represent domain principles as device-independent behavior-function (BF) models. We show that the function of a device determines what to generalize from its SBF model. The SBF model suggests how far to generalize, and the typology of functions indicates what method to use. Author

**N93-19723** Thinkalong Software, Inc., Brownsville, CA.
**GETTING THE MODEL RIGHT: COUPLING A CELLULAR AUTOMATA TO A DISCOVERY SYSTEM** **c61**
Jack Park and Dan Wood *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 82-86 (For primary document see N93-19711 06-82)
(Contract F33615-92-C-5802)
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The modeling of complex systems and their emergent behaviors requires successive refinement of a model. The task for the discovery system is to, with the aid of the scientist, refine and experiment with that model. By coupling a scientific discovery system to a dynamical systems simulation engine, in this case, a cellular automata (CA) machine, it is possible to successively refine models of a dynamical system. This paper focuses on the coupling of a scientific discovery system, called The Scholar's Companion, with a cellular automata engine, serving as a discreet dynamical model of the human immune system. This CA 'laboratory', when fully connected to the Scholar's Companion, should be an interesting arena for experimentation with cellular automata models. Author

**N93-19724** Aberdeen Univ. (Scotland). Dept. of Computing Science.
**MACHINE DISCOVERY BY MODEL DRIVEN ANALOGY** **c61**
Davide Roverso, Peter Edwards, and Derek Sleeman *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 87-97 (For primary document see N93-19711 06-82)
(Grant EEC-SC1-0048-C)
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Analogical reasoning is a crucial inference mechanism in science. We claim that abstract models of scientific situations play a central role in the discovery process and in the search for analogy. We propose a novel mechanism for analogy access and mapping, model driven analogy (MDA), based on the use of abstract models synthesized from a given target situation. We also propose the development of a discovery system, ASIS (Analogical Scientific Investigation System), that uses MDA to find solutions to knowledge problems and that uses experimentation and empirical law discovery to validate the hypotheses formulated by the analogy mechanism. Author

**N93-19725** Paris XI Univ., Orsay (France). Lab. de Recherche en Informatique.
**INFORMAL QUALITATIVE MODELS IN SCIENTIFIC DISCOVERY**
Adrian Gordon *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 98-102 (For primary document see N93-19711 06-82)
(Grant EEC-SC1-0048-C)
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Doing either pure data-driven or pure theory-driven discovery is problematic. Integrating the two techniques can alleviate to some extent the problems arising from the use of each in isolation. It is suggested in this paper that informal qualitative model's (IQM's) offer a framework within which to undertake an integrated discovery strategy. Early stages in the implementation of IQM's in the discovery system HUME are described. Author

**N93-19726** Wichita State Univ., KS. Dept. of Computer Science.
**INCREMENTAL GENERATION AND EXPLORATION OF HIDDEN STRUCTURE**
Paul J. Fischer and Jan M. Zytkow *In its* Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 103-110 (For primary document see N93-19711 06-82)
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Discovering structure has been a universal research task in physics, chemistry, biology, philosophy, and other disciplines. Discovering hidden structure is especially challenging. Not only must all the elements of hidden structure be postulated by the discoverer, but they can only be verified by indirect evidence, available at the level of observable objects. We describe a framework for hidden structure discovery, illustrated with a large scale incremental search for quark models. We present a constructive definition of structure and the operators that can build models of hidden structure step by step, postulating hidden objects, their combinations and attributes, a mapping between the hidden and the observed structure, and reactions described in terms of hidden objects. We demonstrate how domain knowledge on the visible level is useful in operator instantiation and in the global control of search. Because hidden structure cannot be verified by direct observations, a successful model must pass two stages of evaluation. First, its observational consequences must be confirmed, and second, the model must be unique in its simplicity class. We demonstrate the role of additivity and conservation principles at the first stage, and we discuss the uniqueness requirement applied to incremental discovery. Author

**N93-19727** Queens Univ., Kingston (Ontario). Dept. of Computing and Information Science and Chemistry.
**DISCOVERY OF SPATIAL CONCEPTS IN CRYSTALLOGRAPHIC DATABASES**
Darrell Conklin, Suzanne Fortier, Janice Glasgow, and Frank Allen (Cambridge Univ., England ) *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 111-116 (For primary document see N93-19711 06-82)
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This paper describes the application of a machine discovery technique to the domain of molecular classification. We present an incremental concept formation system which manipulates relational, spatial descriptions in the form of images, and learns a subsumption hierarchy of image concepts. As an illustration, the system was tested on 249 hexopyranose sugars extracted from the Cambridge Structural Database. The system was able to discover all 14 configurational classes of the hexopyranose sugars present in the database. Author

**N93-19728** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**AUTOMATING SKY OBJECT CLASSIFICATION IN ASTRONOMICAL SURVEY IMAGES**
Usama M. Fayyad, Richard J. Doyle, Nicholas Weir (California Inst. of Tech., Pasadena.), and S. G. Djorgovski (California Inst. of Tech., Pasadena.) *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 117-125 (For primary document see N93-19711 06-82)
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We describe the application of machine classification techniques to the development of an automated tool for the reduction of a large scientific data set. The 2nd Palomer Observatory Sky Survey is nearly completed. This survey provides comprehensive coverage of the northern celestial hemisphere in the form of photographic plates. The plates are being transformed into digitized images whose quality will probably not be surpassed in the next ten to twenty years. The images are expected to contain on the order of 10(exp 7) galaxies and 10(exp 8) stars. Astronomers wish to determine which of these sky objects belong to various classes of galaxies and stars. The size of this data set precludes manual analysis. Our approach is to develop a software system which integrates the functions of independently developed techniques for image processing and data classification. Digitized sky images are passed through image processing

routines to identify sky objects and to extract a set of features for each object. These routines are used to help select a useful set of attributes for classifying sky objects. Then GID3* and O-BTree, two inductive learning techniques, learn classification decision trees from examples. These classifiers will be used to process the rest of the data. This paper gives an overview of the machine learning techniques used, describes the details of our specific application, and reports the initial encouraging results. The results indicate that our approach is well-suited to the problem. The primary benefits of the approach are increased data reduction throughput and consistency of classification. The classification rules which are the product of the inductive learning techniques will form an object, examinable basis for classifying sky objects. A final, not to be underestimated benefit is that astronomers will be freed from the tedium of an intensely visual task to pursue more challenging analysis and interpretation problems based on automatically cataloged data. Author

**N93-19729** Ministry of Aerospace Industry, Beijing (China). Inst. of Computing Engineering.

**KNOWLEDGE ACQUISITION FROM EXAMPLES WITH MIXED ATTRIBUTES**

Cheng-Jiang Mao *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 126-130 (For primary document see N93-19711 06-82)

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This paper describes a description language that can represent examples and knowledge with mixed attributes: nominal attributes and continuous attributes. As its application, a system of learning from examples with mixed attributes, MIX/A, is presented, and a system of clustering a set of examples with mixed attributes, MIX/C, is outlined. Author

**N93-19730** Kaiserslautern Univ. (Germany). Dept. of Computer Science.

**AUTOMATED DATA ANALYSIS AND DISCOVERY IN NEUROPHYSIOLOGICAL SIMULATION EXPERIMENTS USING A COMBINATION OF NUMERICAL AND SYMBOLIC METHODS**

Stefan Schroedl and Oliver Wendel *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 131-136 (For primary document see N93-19711 06-82)

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Raw data derived from experiments or numerical simulations in a certain domain is at an abstraction level far too low to be used for the interpretation by a computer. In order to detect similarities, relations or dependencies within different data sets, it is often advisable to construct a qualitative description using various transformational steps. Ideally, this process should lead to the same high-level symbolic form that human researchers are used to dealing with themselves. Enabling a system to perform this transformation and to make inferences based on the symbolic description represents a first step towards automatic discovery. In this paper, we report on the above-mentioned aspects of the MOBIS (Modeling of Biological Systems) project, a case-based, interactive simulation environment which is designed to assist neurophysiologists to step through the experiment life-cycle of design, simulation, and analysis of neurophysiological simulation experiments. We are going to present one component of the intelligent assistant whose purpose is to automatically simplify, analyze, and interpret complex numerical neurophysiological data derived from real experiments or - as in our case - from the results of computerized simulation. Author

**N93-19731** Paris XI Univ., Orsay (France). Inference and Learning Group.

**ARC.2: LINEAR REGRESSION IN ABACUS** **c61**

Marjorie Moulet *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 137-146 Sponsored in part by PRC-IA (For primary document see N93-19711 06-82)

(Grant EEC-SC1-0048-C)

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When scientific discovery deals with the problem of discovery of numeric laws, it does similar work as some statistical techniques like regression. It seems natural then to make them collaborate, but some divergences of method make their integration difficult. Mainly, regression needs a specific model of the law that the user usually provides, and that the discovery system should be able to automatically compute. In this paper, we analyze these difficulties and we propose new methods to solve them. We propose to integrate regression as a new operator in our scientific discovery system ARC.2, an improvement of ABACUS (Falkenhainer & Michalski 1986). Some other discovery systems already used the regression, but rather in a theory-driven approach when we integrate it in a wholly data-driven approach. Author

**N93-19732** SRI International Corp., Menlo Park, CA.

**GOAL-DIRECTED LEARNING: A DECISION-THEORETIC MODEL FOR DECIDING WHAT TO LEARN NEXT** **c61**

Marie desJardins *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 147-151 (For primary document see N93-19711 06-82)

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This paper describes a theory called Goal-Directed Learning (GDL) that uses the principle of decision theory to choose learning tasks. The expected utility of being able to predict various features of the environment is computed and those with highest expected utility can be used as learning goals, which an agent's inductive mechanism should form theories to predict. We present a general decision-theoretic formula for the utility of learning goals, formalizing the concept that the best learning goals are those which, if learned, would maximize the agent's expected utility. The performance element of PAGODA (Probabilistic Autonomous GOal-Directed Agent), an autonomous agent design presented in (desJardins, 1992), is described, and a formula is given for the utility of learning goals in PAGODA. Author

**N93-19733** Massachusetts Inst. of Tech., Cambridge. Media Lab.

**CYRANO-3: AN EXPERIMENT IN REPRESENTATIONAL INVENTION** **c61**

Kenneth B. Haase *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 153-160 (For primary document see N93-19711 06-82)

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This article describes CYRANO-3, an autonomous discovery system in the domain of mathematical invention. CYRANO-3 uses a typed functional combinator language as its base representation and a control structure based on a variation of Solomonoff's 'algorithmic probability'. Constructed definitions are assessed by identifying those 'polygenic behaviors' which can be computed in many different ways. The results of this assessment are used to bias future generation towards those operations and fragments which produced the convergent behaviors. In addition, procedural reification transforms domain operations at one level into domain objects at another level; the operations at this higher level are the higher order operations which were successful at the lower level. CYRANO-3 surpasses AM in certain regards but had its own failures; our analysis of these failures points to a framework for understanding representational invention which focuses on the distinction between the representational design constraints 'obvious things should be interesting' and 'interesting things should be obvious'; the first of these is important to an effective discovery system which produces significant results with limited resources; the second is vital to an adaptable whose descriptive scope must embrace the range of possibly interesting constructions. Author

**N93-19734** Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Psychology.

**THE EVALUATION AND REPORTING OF DISCOVERY SYSTEMS**

Herbert A. Simon and Raul E. Valdes-Perez *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 163-165 (For primary document see N93-19711 06-82)

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For several decades there has been considerable interest within artificial intelligence (AI) and cognitive science in building computer simulations of the processes of scientific discovery, in the spirit of constructing expert systems (automated discovery), or directed toward understanding how human scientists make discoveries. Here, we will consider both lines of inquiry, but with emphasis on the AI aspects. Our central concern will be with specificity and generality. How do we compare the merits of discovery programs that are efficacious in one domain with those that have generality over several or many? How can we develop a common language to describe systems for different domains, thereby carrying the experience gained in systems into explorations of others? Most of what we have to say is not peculiar to discovery systems, but applies to all kinds of expert systems. Hence, we will not entirely limit our discussion to discovery tasks.

We will focus on computer programs as research vehicles, without implying that all worthwhile research on the subject should result in a computer program. Author

**N93-19735** Hunter Coll., New York, NY. Dept. of Computer Science.
**EVALUATING MACHINE DISCOVERY SYSTEMS**
Cullen Schaffer and Armand Prieditis (California Univ., Davis.) *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 166 (For primary document see N93-19711 06-82)
Copyright Avail: Issuing Activity

A basic methodological principle of scientific work is that claims or hypotheses should be clearly stated and soundly evaluated. This position paper examines some of the ways that evaluation of machine discovery systems could be improved by stricter adherence to this principle. Author

**N93-19736** Marmara Research Inst., Gebze (Turkey).
**EVALUATION OF DISCOVERY SYSTEMS**
Sakir Kocabas *In* Wichita State Univ., Proceedings of the ML-92 Workshop on Machine Discovery (MD-92) Jul. 1992 p 168-171 (For primary document see N93-19711 06-82)
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Computational modeling of scientific discovery is emerging as one of the most interesting and active research fields in artificial intelligence (AI). The number of systems designed for modeling discovery in various fields of science has been steadily increasing. Involvement in this field is not confined to several small research groups in AI any more. Philosophers and historians of science, as well as cognitive psychologists, are also becoming increasingly interested in research in this field. In current systems, different methods of representation, learning, and discovery are implemented. Also, the degree of reliance on background knowledge varies from one system to another. Moreover, each system focuses on a certain type of scientific discovery. Therefore, a sound methodology for evaluating these computational models seems to be necessary. Author

**N93-19738#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**EVALUATION OF THE GEOMETRIC QUALITY OF CARTOGRAPHIC DOCUMENTS THROUGH THE USE OF SCANNING IMAGERY DEVICES [AVALIACAO DA QUALIDADE GEOMETRICA DE DOCUMENTOS CARTOGRAFICOS OBTIDOS ATRAVES DE DISPOSITIVOS IMAGEADORES POR VARREDURA]**
Julio Cesar Lima DAlge and Guaraci Jose Erthal Oct. 1991 7 p In PORTUGESE
(INPE-5298-PRE/1703) Avail: CASI HC A02/MF A01

Manual digitizing of cartographic documents is a difficult task, which yields questionable results in terms of precision. An alternative is quick acquisition by means of a scanning device. The processing cost is then transferred to the next steps: radiometric correction, segmentation, data reduction, image navigation, vectorizing, symbol and character recognition, edition, and generation of topological structure. Image navigation is a very important step in this procedure. It associates image coordinates to their original projection coordinates. This work presents a geometric quality evaluation of maps obtained through a scanner, with the purpose of verifying its performance. The evaluation results can also determine which mathematical model shall be used in the image navigation step. Author

**N93-19796#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Technical Information Panel.
**A RESEARCH AGENDA FOR SCIENTIFIC AND TECHNICAL INFORMATION [UN PROGRAMME DE RECHERCHE POUR L'INFORMATION SCIENTIFIQUE ET TECHNIQUE]**
Nov. 1992 61 p Workshop held in Lisbon, Portugal, 7-9 Apr. 1992
(AGARD-AR-316; ISBN-92-835-0691-X) Avail: CASI HC A04/MF A01

The results of a workshop are presented and includes three position papers on user needs, information access, and the organization and transfer of information, prepared by the authors as a result of the discussions at the workshop. The outcome of the workshop, in the form of a 53-item research agenda, is given under the headings: information management; provision of information; and access to information. Each is examined from the aspects of human resources, quality assurance, cost, and technology, where appropriate. The report also includes a list of 15 additional areas meriting further investigation, which were identified by participants, during the final session of the workshop. For individual titles, see N93-19797 through N93-19800.

**N93-19797*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**ESTABLISHING A RESEARCH AGENDA FOR SCIENTIFIC AND TECHNICAL INFORMATION (STI): FOCUS ON THE USER**
Thomas E. Pinelli *In* AGARD, A Research Agenda for Scientific and Technical Information Nov. 1992 11 p Previously announced in IAA as A92-48392 (For primary document see N93-19796 06-82)
Avail: CASI HC A03/MF A01

This report addresses the relationship between library science and information science theory and practice, between the development of conceptual understanding, and the practical competence of information professionals. Consideration is given to the concept of research, linking theory with practice, and the reality of theory based practice. Attention is given to the need for research and research priorities, focus on the user and information-seeking behavior, and a user-oriented research agenda for STI. Author

**N93-19798#** Simmons Coll., Boston, MA.
**INFORMATION ACCESS: A RESEARCH AGENDA**
Peter Hernon *In* AGARD, A Research Agenda for Scientific and Technical Information Nov. 1992 18 p (For primary document see N93-19796 06-82)
Avail: CASI HC A03/MF A01

This paper provides a general overview of information access. The issues identified and discussed ultimately have implications for both developed and developing countries. It is important that developing countries recognize and address these issues in national plans and in practice, for the issues relate to information resources management and use, and to scientific, economic, technological, and societal advancement. The proposed research agenda represents an initial effort to offer direction in an information and electronic age. The agenda provides nations, international bodies, agencies, and organizations with a flexible framework for producing change and for linking that change to decision making and policy review, formulation, and implementation. Author

**N93-19799#** University Coll., London (England). Dept. of Computer Science.
**THE ORGANIZATION AND TRANSFER OF INFORMATION**
Bill Tuck *In* AGARD, A Research Agenda for Scientific and Technical Information Nov. 1992 11 p (For primary document see N93-19796 06-82)
Avail: CASI HC A03/MF A01

The objective of this workshop is to develop a research agenda for management and policy issues relating to scientific and technical information. The intention is not only to inform but also to elicit recommendations for further research and study. In particular, it will be important to determine just what it is we do not fully understand, and also to assess the effectiveness of our programs. These two concepts - 'understanding' and 'effectiveness' - form the underlying themes of the following paper. They are not unrelated: it is clearly a possibility that our programs may be ineffective because we do not fully understand the issues on which they are dependent. Conversely, improving their effectiveness will almost certainly require more detailed knowledge of the underlying dynamics. The class of problems toward which this paper is addressed is concerned with the organization and transfer of information. What barriers exist to the effective retrieval and transfer of scientific and technical information? And how does one ensure the quality and integrity of that information? These are complex issues only partly addressed in the present paper, which is intended to provoke discussion rather than provide detailed solutions. Author

**N93-19800*#** National Aeronautics and Space Administration, Washington, DC.
**THE AGARD TIP RESEARCH AGENDA FOR SCIENTIFIC AND TECHNICAL INFORMATION (STI)**
Walter R. Blados *In* AGARD, A Research Agenda for Scientific and Technical Information Nov. 1992 4 p (For primary document see N93-19796 06-82)
Avail: CASI HC A01/MF A01

The Research Agenda contains three themes: information management, provision of information, and access to information. Provision of information is further divided into two subordinate themes, dissemination and bibliographic control; access to information is also further divided into two subordinate themes, barriers and equity and networking. Each theme or sub-theme was examined from four possible aspects, namely, human resources, quality assurance, cost, and technology. It was concluded that, in fact, a theme or sub-theme need not contain all four aspects. Author

**N93-19835#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**METHODS FOR ANALYSIS OF NETWORKS WITHIN A GEOGRAPHICAL INFORMATION SYSTEM [METODOLOGIAS DE ANALISE DE REDES DENTRO DE UM SISTEMA DE INFORMACOES GEOGRAFICA]**

Joao Argemiro deCarvalhoPaiva and Guaraci Jose Erthal Oct. 1991 7 p In PORTUGESE

(INPE-5299-PRE/1704) Avail: CASI HC A02/MF A01

A Geographical Information System (GIS) works with data like thematic maps, satellite images, and digital terrain models. Another kind of data are network maps which represent roads, river, and other similar things. One possible analysis for network structures inside the GIS is described. The information about the maps could be stored in a geographic data base and in a relational data base. Author

**N93-19900*#** National Aeronautics and Space Administration, Washington, DC.

**NASA SCIENTIFIC AND TECHNICAL INFORMATION PROGRAM MULTIMEDIA INITIATIVE**

Gladys A. Cotter and Karen Kaye Jan. 1993 10 p

(NASA-TM-108982; NAS 1.15:108982) Avail: CASI HC A02/MF A01

This paper relates the experiences of the NASA Scientific and Technical Information Program in introducing multimedia within the STI Program framework. A discussion of multimedia technology is included to provide context for the STI Program effort. The STI Program's Multimedia Initiative is discussed in detail. Parallels and differences between multimedia and traditional information systems project development are highlighted. Challenges faced by the program in initiating its multimedia project are summarized along with lessons learned. The paper concludes with a synopsis of the benefits the program hopes to provide its users through the introduction of multimedia illustrated by examples of successful multimedia projects. Author

**N93-19935*#** NASA Center for AeroSpace Information, Baltimore-Washington International Airport, MD.

**AN OPERATIONAL SYSTEM FOR SUBJECT SWITCHING BETWEEN CONTROLLED VOCABULARIES**

June P. Silvester and Paul H. Klingbiel (Klingbiel, Paul H., Clearwater, FL ) 1993 13 p Repr. from Information Processing and Management (England), v. 29, no. 1, 1993 p 47-59

(Contract NASw-4584)

(NASA-CR-192333; NAS 1.26:192333) Copyright Avail: CASI HC A03/MF A01

The NASA system of automatically converting sets of terms assigned by Department of Defense indexers to sets of NASA's authorized terms is described. This little-touted system, which has been operating successfully since 1983, matches concepts, rather than words. Subject Switching uses a translation table, known as the Lexical Dictionary, accessed by a program that determines which rules to follow in making the transition from DTIC's to NASA's authorized terms. The authors describe the four phases of development of Subject Switching, changes that have been made, evaluating the system, and benefits. Benefits to NASA include saving indexers' time, the addition of access points for documents indexed, the utilization of other government indexing, and a contribution towards the now-operational NASA, online, interactive, machine aided indexing. Author

**N93-19936*#** National Aeronautics and Space Administration, Washington, DC.

**MODERNIZATION OF THE NASA SCIENTIFIC AND TECHNICAL INFORMATION PROGRAM**

Gladys A. Cotter, Judy F. Hunter, and K. Ostergaard Mar. 1993 10 p

(NASA-TM-108984; NAS 1.15:108984) Avail: CASI HC A02/MF A01

The NASA Scientific and Technical Information Program utilizes a technology infrastructure assembled in the mid 1960s to late 1970s to process and disseminate its information products. When this infrastructure was developed it placed NASA as a leader in processing STI. The retrieval engine for the STI database was the first of its kind and was used as the basis for developing commercial, other U.S., and foreign government agency retrieval systems. Due to the combination of changes in user requirements and the tremendous increase in technological capabilities readily available in the marketplace, this infrastructure is no longer the most cost-effective or efficient methodology available. Consequently, the NASA STI Program is pursuing a modernization effort that applies new technology to current processes to provide near-term benefits to the user. In conjunction with this activity, we are developing a long-term modernization strategy designed to transition the Program to a multimedia, global 'library without walls.' Critical pieces of the long-term strategy include streamlining access to sources of STI by using advances in computer networking and graphical user interfaces; creating and disseminating technical information in various electronic media including optical disks, video, and full text; and establishing a Technology Focus Group to maintain a current awareness of emerging technology and to plan for the future. Author

**N93-19937*#** National Aeronautics and Space Administration, Washington, DC.

**NASA SCIENTIFIC AND TECHNICAL PROGRAM: USER SURVEY**

Judy F. Hunter and Cynthia W. Shockley (Logistics Management Inst., Bethesda, MD.) Jan. 1993 11 p Previously announced in IAA as A93-23313

(NASA-TM-108979; NAS 1.15:108979) Avail: CASI HC A03/MF A01

Results are presented of an intensive user requirements survey conducted by NASA's Scientific and Technical Information (STI) Program with the goal of improving the foundation for the user outreach program. The survey was carried out by interviewing 550 NASA scientists, engineers, and contractors and by analyzing 650 individual responses to a mailed out questionnaire. To analyze the user demographic data, a data base was built and used, and will be applied to ongoing analysis by the NASA STI Program. AIAA

**N93-19939*#** National Aeronautics and Space Administration, Washington, DC.

**NASA ACCESS MECHANISM: GRAPHICAL USER INTERFACE INFORMATION RETRIEVAL SYSTEM**

Judy Hunter, Curtis Generous, and Denise Duncan (Logistics Management Inst., Bethesda, MD.) Jan. 1993 10 p Previously announced in IAA as A93-23314

(NASA-TM-108981; NAS 1.15:108981) Avail: CASI HC A02/MF A01

Access to online information sources of aerospace, scientific, and engineering data, a mission focus for NASA's Scientific and Technical Information Program, has always been limited to factors such as telecommunications, query language syntax, lack of standardization in the information, and the lack of adequate tools to assist in searching. Today, the NASA STI Program's NASA Access Mechanism (NAM) prototype offers a solution to these problems by providing the user with a set of tools that provide a graphical interface to remote, heterogeneous, and distributed information in a manner adaptable to both casual and expert users. Additionally, the NAM provides access to many Internet-based services such as Electronic Mail, the Wide Area Information Servers system, Peer Locating tools, and electronic bulletin boards. Author

**N93-19203*#** Westfield Coll., London (England).

**PHILOSOPHY AND UPDATING OF THE ASTEROID PHOTOMETRIC CATALOGUE**

Per Magnusson, M. Antonietta Barucci (Observatoire de Paris-Meudon, France ), M. T. Capria (Viale Univ., Rome, Italy ), Mats Dahlgren (Astronomical Observatory, Uppsala, Sweden ), Marcello Fulchignoni (La Sapienza Univ., Rome, Italy ), and C. I. Lagerkvist (Astronomical Observatory, Uppsala, Sweden ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 379-380 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

## 83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

**N93-17853#** National Science Foundation, Washington, DC. Div. of Science Resource Studies.
**FEDERAL FUNDS FOR RESEARCH AND DEVELOPMENT: FISCAL YEARS 1990, 1991, AND 1992, VOLUME 40**
Jul. 1992 366 p
(NSF-92-322-Vol-40) Avail: CASI HC A16/MF A03

Data in the tables of this publication were derived from the Survey of Federal Funds for Research and Development, Volume 40, for fiscal years (FY's) 1990-92. They reflect research and development (R&D) funding levels as reported by 33 Federal agencies in March through October 1991. All agencies that conduct R&D programs were surveyed. Author

**N93-19436*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Radio Frequency and Microwave Sybsystems Section.
**A MODEL FOR THE COST OF DOING A COST ESTIMATE**
D. S. Remer (Harvey Mudd Coll., Claremont, CA.) and H. R. Buchanan *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 278-284 (For primary document see N93-19413 06-32)
(RTOP 314-40-31-30-03)
Avail: CASI HC A02/MF A03

## 84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

No abstracts in this category.

## 85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

**N93-18169*#** National Aeronautics and Space Administration, Washington, DC.
**STRATEGIC FACTORS IN THE DEVELOPMENT OF THE NATIONAL TECHNOLOGY TRANSFER NETWORK**
Jonathan F. Root and Barbara A. Stone 1993 9 p Proposed for presentation at the Thirtieth Space Congress, Cocoa Beach, FL, 27-30 Apr. 1993
(NASA-TM-108594; NAS 1.15:108594) Avail: CASI HC A02/MF A01

Broad consensus among industry and government leaders has developed over the last decade on the importance of applying the U.S. leadership in research and development (R&D) to strengthen competitiveness in the global marketplace, and thus enhance national prosperity. This consensus has emerged against the backdrop of increasing economic competition, and the dramatic reduction of military threats to national security with the end of the Cold War. This paper reviews the key factors and considerations that shaped - and continue to influence - the development of the Regional Technoloty Transfer Centers (RTTC) and the National Technology Transfer Center (NTTC). Also, the future role of the national network in support of emerging technology policy initiatives will be explored. I.I.C.

**N93-18457#** National Science Foundation, Washington, DC. Engineering Centers Div.
**HIGHLIGHTS OF ENGINEERING RESEARCH CENTERS TECHNOLOGY TRANSFER**
1992 52 p
(NSF-92-6) Avail: CASI HC A04/MF A01

The Engineering Research Centers (ERC) Program of the National Science Foundation (NSF) is one of the NSF's most ambitious undertakings in recent years; it represents the largest single initiative in engineering that NSF has ever embarked upon. Established by the NSF Directorate for Engineering in 1985, the ERC Program was charged with a vital mission: strengthening competitiveness by bringing new approaches and goals to academic engineering research and education, and by forging vital new links between universities and industry. The three main elements of this mission are cross-disciplinary research, education, and industrial collaboration and technology transfer. A description of each center is provided in terms of industry technology transfer. Author

**N93-18533#** Pacific Northwest Lab., Richland, WA.
**TECH TRANSFER OUTREACH**
S. Liebetrau, ed. 1992 45 p Presented at the First Technology/Communications Conference: Tech Transfer Outreach, Richland, WA, 19-21 May 1992
(Contract DE-AC06-76RL-01830)
(DE93-001553; PNL-SA-21348; CONF-9205241) Avail: CASI HC A03/MF A01

This document provides an informal summary of the conference workshop sessions. 'Tech Transfer Outreach' was originally designed as an opportunity for national laboratory communications and technology transfer staff to become better acquainted and to discuss matters of mutual interest. When DOE field office personnel asked if they could attend, and then when one of our keynote speakers became a participant in the discussions, the actual event grew in importance. The conference participants--the laboratories and DOE representatives from across the nation--worked to brainstorm ideas. Their objective: identify ways to cooperate for effective (and cost-effective) technology transfer outreach. Thus, this proceedings is truly a product of ten national laboratories and DOE, working together. It candidly presents the discussion of issues and the ideas generated by each working group. The issues and recommendations are a consensus of their views. DOE

**N93-18762*#** Garrett Corp., Phoenix, AZ.
**ADVANCED TURBINE TECHNOLOGY APPLICATIONS PROJECT (ATTAP) Annual Report, 1991**
Jun. 1992 149 p Sponsored by DOE, Washington, DC
(Contract DEN3-335)
(NASA-CR-189228; NAS 1.26:189228; Rept-31-8071(04); DOE/NASA/0335-4) Avail: CASI HC A07/MF A02

This report is the fourth in a series of Annual Technical Summary Reports for the Advanced Turbine Technology Applications Project (ATTAP). This report covers plans and progress on ceramics development for commercial automotive applications over the period 1 Jan. - 31 Dec. 1991. Project effort conducted under this contract is part of the DOE Gas Turbine Highway Vehicle System program. This program is directed to provide the U.S. automotive industry the high-risk, long-range technology necessary to produce gas turbine engines for automobiles with reduced fuel consumption, reduced environmental impact, and a decreased reliance on scarce materials and resources. The program is oriented toward developing the high-risk technology of ceramic structural component design and fabrication, such that industry can carry this technology forward to production in the 1990s. The ATTAP test bed engine, carried over from the previous AGT101 project, is being used for verification testing of the durability of next-generation ceramic components, and their suitability for service at Reference Powertrain Design conditions. This document reports the technical effort conducted by GAPD and the ATTAP subcontractors during the fourth year of the project. Topics covered include ceramic processing definition and refinement, design improvements to the ATTAP test bed engine and test rigs and the methodology development of ceramic impact and fracture mechanisms. Appendices include reports by ATTAP subcontractors in the development of silicon nitride and silicon carbide families of materials and processes. Author

**N93-19389*#** National Academy of Sciences - National Research Council, Washington, DC. Committee on Space Science Technology Planning.
**IMPROVING NASA'S TECHNOLOGY FOR SPACE SCIENCE**
1993 109 p
(Contracts NASw-4003; NASw-4627)
(NASA-CR-192331; NAS 1.26:192331; LC-93-83194) Copyright Avail: CASI HC A06/MF A02; the Aeronautics and Space Engineering Board and the Space Studies Board, 2101 Constitution Avenue, NW, Washington, DC 20418

The continued advance of the nation's space program is directly dependent upon the development and use of new technology. Technology is the foundation for every aspect of space missions and ground operations. The improvements in technology that will enable future advances are not only in device and system performance, but also in permitting missions to be carried out more rapidly and at lower cost. Although more can be done with current technology, NASA's recent call for new and innovative approaches should not be answered by employing only today's technologies; new technologies with revolutionary potential should be sought. The study reported here was performed to identify means to enhance the development of technologies for the space sciences and applications. Author

**N93-19741#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**TECHNOLOGY ABSORPTION AND TECHNOLOGICAL LEARNING: A STUDY OF THE DYNAMICS OF THE PROCESS AND INTERVENING FACTORS [A ABSORCAO DE TECNOLOGIA E O APRENDIZADO TECNOLOGICO: UM ESTUDO DA DINAMICA DO PROCESSO E DE FATORES INTERVENIENTES]**
Antonio Marcio Piccina Apr. 1992 199 p In PORTUGESE
(INPE-5392-TAE/013) Avail: CASI HC A09/MF A03

This work intends to identify and analyze some of the factors that influence the process of technological absorption and learning, focusing on Brazilian organizations both in the productive and in the R&D sectors. It is composed of three major parts. The first one searches for factors that have been identified and analyzed in the literature on models of the technological innovation process, on technology transfer, and on technological learning. The second part proposes a conceptual model for the subject and describes the methodology chosen for the analytical treatment of the problem. The last part presents the results obtained from a survey involving 32 organizations (29 firms and 3 R&D institutes), based on interviews guided by a questionnaire. It also offers conclusions and recommendations which are drawn upon the results of the study and take into account the present economic situation of the country.
Transl. by FLS

## 88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

## 89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

**N93-17978#** Naval Postgraduate School, Monterey, CA.
**DESIGN OF A MICROPROCESSOR-BASED CONTROL SYSTEM CONTROL SYSTEM FOR THE MONTEREY INSTITUTE FOR RESEARCH IN ASTRONOMY 36 IN. TELESCOPE M.S. Thesis**
David P. Wood Jun. 1992 171 p
(AD-A257554) Avail: CASI HC A08/MF A02

The use of computer technology to control large pointing systems can significantly improve performance and reduce human work load. The goal of this thesis was to design software for an inexpensive, yet accurate and efficient control system for the 36-inch reflecting telescope owned and operated by the Monterey Institute for Research in Astronomy. Within this thesis, a computer program is developed to automatically move the telescope to a set of celestial coordinates and track with an accuracy of one-tenth of an arc second for five minutes within 75 deg of the zenith. Set times are anticipated to be between four and thirty seconds. Corrections are made to celestial coordinates to account for precession, nutation, aberration, and atmospheric refraction effects. The user is provided an interface to the computer-based system that allows storage and editing of 100 star positions, editing of the system parameters, and display of the telescope's status. Manual control of the telescope is also permitted at any time. Safety of the telescope structure is the primary concern of system software. GRA

**N93-18115*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace Engineering.
**PARAS PROGRAM: PHASED ARRAY RADIO ASTRONOMY FROM SPACE**
Antoni K. Jakubowski, David A. Haynes (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), Ken Nuss, Chris Hoffmann, Michael Madden, and Michael Dungan 1992 211 p
(Contract NASw-4435)
(NASA-CR-192025; NAS 1.26:192025) Avail: CASI HC A10/MF A03

An orbiting radio telescope is proposed which, when operated in a Very Long Baseline Interferometry (VLBI) scheme, would allow higher (than currently available) angular resolution and dynamic range in the maps, and the ability of observing rapidly changing astronomical sources. Using a passive phases array technology, the proposed design consists of 656 hexagonal modules forming a 150 meter diameter dish. Each observatory module is largely autonomous, having its own photovoltaic power supply and low-noise receiver and processor for phase shifting. The signals received by the modules are channeled via fiber optics to the central control computer in the central bus module. After processing and multiplexing, the data is transmitted to telemetry stations on the ground. The truss frame supporting each observatory pane is a hybrid structure consisting of a bottom graphite/epoxy tubular triangle and rigidized inflatable Kevlar tubes connecting the top observatory panel and bottom triangle. Attitude control and stationkeeping functions are performed by a system of momentum wheels in the bus and four propulsion modules located at the compass points on the periphery of the observatory dish. Each propulsion module has four monopropellant thrusters and six hydrazine arcjets, the latter supported by a nuclear reactor. The total mass of the spacecraft is 22,060 kg. Author

**N93-18163*#** Texas Univ., Austin. Dept. of Aerospace Engineering.
**FLARE: THE FAR SIDE LUNAR RESEARCH EXPEDITION. A DESIGN OF A FAR SIDE LUNAR OBSERVATORY**
David W. Bishop, Rudhmala P. Chakrabarty, Dawn M. Hannula, William A. Hargus, Jr., A. Dean Melendrez, Christopher J. Niemann, Amy L. Neuenschwander, Brett D. Padgett, Sanjiv R. Patel, and Leland J. Wiesehuegel 6 Dec. 1991 154 p
(Contract NASw-4435)
(NASA-CR-192029; NAS 1.26:192029) Avail: CASI HC A08/MF A02

This document outlines the design completed by members of Lone Star Aerospace, Inc. (L.S.A.) of a lunar observatory on the far side of the Moon. Such a base would not only establish a long term human presence on the Moon, but would also allow more accurate astronomical data to be obtained. A lunar observatory is more desirable than an Earth based observatory for the following reasons: instrument weight is reduced due to the Moon's weaker gravity; near vacuum conditions exist on the Moon; the Moon has slow rotation to reveal the entire sky; and the lunar surface is stable for long baseline instruments. All the conditions listed above are favorable for astronomical data recording. The technical aspects investigated in the completion of this project included site selection, mission scenario, scientific instruments, communication and power systems, habitation and transportation, cargo spacecraft design, thermal systems, robotic systems, and trajectory analysis. The site selection group focused its efforts on finding a suitable location for the observatory. Hertzsprung, a large equatorial crater on the eastern limb, was chosen as the base site. Author

**N93-18415*#** Columbia Univ., New York, NY. Columbia Astrophysics Lab.

**PRE-PHASE A: DEVELOPMENT OF A FAR-ULTRAVIOLET PHOTOMETRIC- AND SPECTROSCOPIC-SURVEY SMALL-EXPLORER EXPERIMENT Final Technical Report, 1 Nov. 1991 - 31 Oct. 1992**

Christopher Martin Feb. 1993 149 p

(Grant NAGw-1887)

(NASA-CR-192092; NAS 1.26:192092; CAL-2064) Avail: CASI HC A07/MF A02

We propose to perform a far ultraviolet photometric and spectroscopic survey covering the lambda lambda 1300-2000 band with a sensitivity comparable to that of the Palomar Sky Survey. This survey will proceed in three phases: an all-sky survey in three bands to 18-19.5(sup m), deep surveys of selected targets of interest in the same bands to 21-22(sup m), and a spectroscopic survey of 2 percent of the sky to 18(sup m) with a resolution of 3-20A. This mission, the Joint Ultraviolet Nightsky Observer (JUNO), can be performed by a Small-Explorer-class satellite. Author

**N93-18607*#** Harvard Coll. Observatory, Cambridge, MA. Center for Astrophysics.

**EXITE/IPC OBSERVATIONS OF SN1987A AND SOUTHERN TARGETS Final Report**

Jonathan E. Grindlay 17 Sep. 1991 8 p

(Grant NAGw-1721)

(NASA-CR-192133; NAS 1.26:192133) Avail: CASI HC A02/MF A01

The Energetic X-ray Imaging Telescope Experiment (EXITE) was developed to a flight-ready status and conducted two flights (May 18, 1988, and May 8-10, 1989) from Alice Springs, Australia, as part of the campaigns to observe the supernova SN1987A. The basic operation of the detector and gondola systems in the laboratory was tested on the first flight and found to meet expected performance values. A bizarre 'balloon tape' insulation problem, however, prevented normal telescope pointing on the first flight so no data on SN1987A or other targets were obtained. Following a successful second EXITE flight from Ft. Sumner, NM, in October 1988, the experiment was flown again on a successful 30 hour flight as part of the final 1989 supernova campaign. A second x-ray imaging experiment from MSFC was also flown (piggy-back) for this third flight. Good data were obtained on the supernova and a variety of high priority galactic targets, and final analysis is still in progress. Preliminary results from this flight are presented. Author

**N93-18776*#** Delaware Univ., Newark. Bartol Research Inst.

**FLUCTUATIONS AT THE BLUE EDGE OF SATURATED WIND LINES IN IUE SPECTRA OF O-TYPE STARS Semiannual Report, 1 Jul. - 31 Dec. 1992**

Stanley P. Owocki and Alex Fullerton 8 Jan. 1993 8 p

(Grant NAG5-1657)

(NASA-CR-191887; NAS 1.26:191887) Avail: CASI HC A02/MF A01

We examine basic issues involved in synthesizing resonance-line profiles from 1-D, dynamical models of highly structured hot-star winds. Although these models exhibit extensive variations in density as well as velocity, the density scale length is still typically much greater than the Sobolev length. The line transfer is thus treated using a Sobolev approach, as generalized by Rybicki & Hummer (1978) to take proper account of the multiple Sobolev resonances arising from the nonmonotonic velocity field. The resulting reduced-Lambda-matrix equation describing nonlocal coupling of the source function is solved by iteration, and line profiles and then derived from formal solution integration using this source function. The more appropriate methods that instead use either a stationary or a structured, local source function yield qualitatively similar line-profiles, but are found to violate photon conservation by 10 percent or more. The full results suggest that such models may indeed be able to reproduce naturally some of the qualitative properties long noted in observed UV line profiles, such as discrete absorption components in unsaturated lines, or the blue-edge variability in saturated lines. However, these particular models do not yet produce the black absorption troughs commonly observed in saturated lines, and it seems that this and other important discrepancies (e.g., in acceleration time scale of absorption components) may require development of more complete models that include rotation and other 2-D and/or 3-D effects. Author

**N93-19047** Princeton Univ., NJ.

**TWO HIGH-SENSITIVITY PULSAR SEARCHES Ph.D. Thesis**

David John Nice 1992 125 p

Avail: Univ. Microfilms Order No. DA9235267

We have undertaken a program of two searches at radio wavelengths for pulsars using the Arecibo Observatory. One search covered 70 square degrees of sky along the Galactic plane with sensitivity to pulsars with periods as short as 1 ms. The second search covered 170 square degrees between galactic latitudes -50 degrees and -30 degrees with sensitivity to pulsars with periods of 0.5 ms or more. The sensitivity to long-period pulsars in both surveys was of order 1 mJy, with reduced sensitivity at the shortest periods. Twenty-five pulsars were detected between the two surveys. Ten of these had previously been discovered. Of the remaining fifteen new pulsars, thirteen are relatively young, slow pulsars, with periods between 0.212 s and 5.094 s. The latter period is the longest of any known radio pulsar; this pulsar also has an extraordinarily short duty cycle of 0.4 percent. Two millisecond pulsars were found. PSR J2019+2425 has a period of 3.934 ms and is at a distance of approx. 1 kpc. It is in a 76.5-day binary orbit with an approx. 0.3 solar mass companion. Its orbital eccentricity is 1.1 x 10(exp -4). The spin-down rate of this pulsar is extremely small, and its evolutionary timescales of 9 x 10(exp 9) yr is the longest of any known pulsar. Both the low eccentricity and the long evolutionary timescale put limits on violations of the strong equivalence principle which are competitive with the best previous limits. The second newly found millisecond pulsar, PSR J2322+2057, has a period of 4.808 ms and a distance of approx. 0.8 kpc. It is the second isolated millisecond pulsar found outside a globular cluster. Its distance of nearly approx. 0.5 kpc from the galactic plane suggests that millisecond pulsars have a large scale height.

Dissert. Abstr.

**N93-18497#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**INFRARED STUDIES OF STAR-FORMING REGIONS**

J. A. Hackwell, L. M. Friesen, D. K. Lynch, and R. W. Russell *In its* Aerospace Sponsored Research 1 Dec. 1991 p 123-125 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

**N93-18710*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.

**BBXRT AND GINGA OBSERVATIONS OF THE SEYFERT 1 GALAXY MRK 335 Abstract Only**

T. J. Turner, K. Nandra (Leicester Univ., England ), G. M. Madejski (Universities Space Research Association, Greenbelt, MD.), F. Marshall, R. F. Mushotzky, R. Petre, K. A. Pounds (Leicester Univ., England ), A. P. Smale, P. Serlemitsos, and K. Weaver (Maryland Univ., College Park.) et al *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)

Avail: CASI HC A01/MF A03

**N93-18711*#** Cambridge Univ. (England).

**THE BROAD-BAND X RAY SPECTRAL VARIABILITY OF Mkn 841 Abstract Only**

I. M. George, K. Nandra, A. C. Fabian, T. J. Turner (National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.), C. Done (National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.), and C. S. R. Day (Tokyo Univ., Sagamihara, Japan ) *In* NASA. Goddard Space Flight Center, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)

Avail: CASI HC A01/MF A03

**N93-18712*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.

**THE X RAY VARIABILITY OF NGC6814: POWER SPECTRA Abstract Only**

C. Done, G. M. Madejski, R. F. Mushotsky, T. J. Turner, K. Koyama (Nagoya Univ., Japan ), and H. Kunieda (Nagoya Univ., Japan ) *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 2 p (For primary document see N93-18709

06-42)
Avail: CASI HC A01/MF A03

**N93-18713*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.
**THE X RAY VARIABILITY OF AGN AND THE ANOMALOUS BEHAVIOR OF NGC6814 Abstract Only**
C. Done, G. M. Madejski, R. F. Mushotzky, T. J. Turner, K. Koyama (Nagoya Univ., Japan ), and H. Kunieda (Nagoya Univ., Japan ) *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

**N93-18714*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.
**EVIDENCE FOR A MASSIVE STELLAR BLACK HOLE IN X RAY NOVA MUSCAE**
Wan Chen, Neil Gehrels (Universities Space Research Association, Greenbelt, MD.), and F. H. Cheng (Space Telescope Science Inst., Baltimore, MD.) *In its* Goddard Visiting Scientist Program for the Space and Earth Directorate 1 Dec. 1992 14 p (For primary document see N93-18709 06-42)
Avail: CASI HC A03/MF A03

**N93-18715*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.
**COBE DIFFERENTIAL MICROWAVE RADIOMETER (DMR) DATA PROCESSING TECHNIQUES Abstract Only**
P. D. Jackson, G. F. Smoot (California Univ., Berkeley.), C. L. Bennett (California Univ., Berkeley.), J. Aymon, C. Backus, G. DeAmici, G. Hinshaw (Universities Space Research Association, Greenbelt, MD.), P. B. Keegstra, A. Kogut, and C. Lineweaver (California Univ., Berkeley.) et al *In its* Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

**N93-18717*#** California Univ., Berkeley. Dept. of Physics and Space Sciences Lab.
**A BOLOMETRIC MILLIMETER-WAVE SYSTEM FOR OBSERVATIONS OF ANISOTROPY IN THE COSMIC MICROWAVE BACKGROUND RADIATION ON MEDIUM ANGULAR SCALES Abstract Only**
M. L. Fischer, D. C. Alsop, E. S. Cheng, A. C. Clapp, D. A. Cottingham, J. O. Gundersen, T. C. Koch (California Univ., Santa Barbara.), E. Kreysa (Max-Planck-Inst. fuer Radioastronomie, Bonn, Germany ), P. R. Meinhold (California Univ., Santa Barbara.), and A. E. Lange et al *In* NASA. Goddard Space Flight Center, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 1 Dec. 1992 1 p (For primary document see N93-18709 06-42)
Avail: CASI HC A01/MF A03

**N93-18825*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AN APPLICATION OF THE OBSERVER/KALMAN FILTER IDENTIFICATION (OKID) TECHNIQUE TO HUBBLE FLIGHT DATA**
Jer-Nan Juang, Lucas G. Horta, W. Keith Belvin, John Sharkey (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.), and Frank H. Bauer (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.) *In its* The Fifth NASA/DOD Controls-Structures Interaction Technology Conference, Part 1 Feb. 1993 p 97-112 (For primary document see N93-18818 06-18)
Avail: CASI HC A03/MF A04

**N93-19129*#** Observatoire de Paris (France). Section de Meudon.
**OBSERVATIONS OF OH IN COMET LEVY WITH THE NANCAY RADIO TELESCOPE**
Dominique Bockelee-Morvan, P. Colom, Jacques Crovisier, E. Gerard, and G. Bourgois *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 73-76 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19143*#** Observatoire de Paris (France). Section de Meudon.
**OBSERVATIONS OF COMETARY PARENT MOLECULES WITH THE IRAM RADIO TELESCOPE**
P. Colom, D. Despois (Bordeaux Univ., France ), G. Paubert (Instituto de Radioastronomia, Granada, Spain ), D. Bockelee-Morvan, and Jacques Crovisier *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 133-136 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19144*#** Observatoire de Paris (France). Section de Meudon.
**RADIO SPECTROSCOPY OF COMETS: RECENT RESULTS AND FUTURE PROSPECTS**
Jacques Crovisier *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 137-140 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19149*#** Osservatorio Astronomico, Turin (Italy).
**A PHOTOMETRIC SURVEY OF OUTER BELT ASTEROIDS**
M. DiMartino, M. Gonano-Beurer (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany ), Stefano Mottola (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany ), and G. Neukum (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 157-160 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19153*#** Johns Hopkins Univ., Baltimore, MD. Dept. of Physics and Astronomy.
**IUE OBSERVATIONS OF PERIODIC COMETS TEMPEL-2, KOPFF, AND TEMPEL-1**
Paul D. Feldman and Michel C. Festou (Observatoire de Midi-Pyresnees, Toulouse, France ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 171-174 (For primary document see N93-19113 06-90)
(Grant NsG-5393)
Avail: CASI HC A01/MF A04

**N93-19158*#** Queens Univ., Belfast (Northern Ireland). Dept. of Physics.
**SPECTROSCOPY OF D-TYPE ASTEROIDS**
Alan Fitzsimmons, Mats Dahlgren (Astronomical Observatory, Uppsala, Sweden ), C.-I. Lagerkvist (Astronomical Observatory, Uppsala, Sweden ), Per Magnusson (Westfield Coll., London, England ), and I. P. Williams (Westfield Coll., London, England ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 191-194 Sponsored in part by Science Research Council and Swedish Research Council (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19169*#** Arizona State Univ., Tempe.
**SPECTROSCOPIC OBSERVATIONS OF COMET AUSTIN (1989c)**
Rodney Heyd, Susan Wyckoff, Peter Wehinger, and Peter Mack (Massachusetts Inst. of Tech., South Dartmouth.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 241-244 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19178*#** University of Western Ontario, London. Dept. of Physics.
**FORWARD-SCATTER RADIANT MAPPING**
James Jones and A. R. Webster *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 273-276 Sponsored by Supply and Services Canada (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19180*#** Sheffield Univ. (England). Dept. of Physics.
**OBSERVATION OF METEORS BY MST RADAR**
William Jones and S. P. Kingsley *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 281-284 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19182*#** Helsinki Univ. (Finland). Observatory and Astrophysics Lab.
**INVERSION METHODS FOR INTERPRETATION OF ASTEROID LIGHTCURVES**
Mikko Kaasalainen, L. Lamberg, and K. Lumme *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 289-292 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19205*#** Red Deer Coll. (Alberta).
**THE ELEVEN OBSERVATIONS OF COMETS BETWEEN 687 AD AND 1114 AD RECORDED IN THE ANGLO SAXON CHRONICLE**
E. G. Mardon, J. Williams, and A. A. Mardon *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 385-393 Prepared in cooperation with Texas A&M Univ., College Station (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

**N93-19206*#** Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
**THE RECOVERY OF ASTEROIDS AFTER TWO OBSERVATIONS**
Brian G. Marsden *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 395-398 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19210*#** California Univ., San Diego, La Jolla. Space Inst.
**NEAR INFRARED REFLECTANCE SPECTRA: APPLICATIONS TO PROBLEMS IN ASTEROID-METEORITE RELATIONSHIPS**
Lucy A. McFadden and Alan B. Chamberlin *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 413-416 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19212*#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany). German Aerospace Research Establishment.
**GROUND-BASED OBSERVATIONS OF 951 GASPRA: CCD LIGHTCURVES AND SPECTROPHOTOMETRY WITH THE GALILEO FILTERS**
Stefano Mottola, M. DiMartino (Osservatorio Astronomico, Turin, Italy ), M. Gonano-Beurer, H. Hoffmann, and G. Neukum *In* Lunar and Planetary Inst. Asteroids, Comets, Meteors 1991 1992 p 421-424 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19213*#** Kitt Peak National Observatory, Tucson, AZ.
**CCD-PHOTOMETRY OF COMETS AT LARGE HELIOCENTRIC DISTANCES**
Beatrice E. A. Mueller *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 425-428 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19217*#** Lowell Observatory, Flagstaff, AZ.
**15 YEARS OF COMET PHOTOMETRY: A COMPARATIVE ANALYSIS OF 80 COMETS**
David J. Osip (Florida Univ., Gainesville.), David G. Schleicher, Robert L. Millis, M. F. A. Hearn (Maryland Univ., College Park.), and P. V. Birch (Perth Observatory, Australia ) *In* Lunar and Planeraty Inst., Asteroids, Comets, Meteors 1991 1992 p 443-445 (For primary document see N93-19113 06-90)
(Grants NAGw-2366; NSF AST-87-18087)
Avail: CASI HC A01/MF A04

**N93-19219*#** Institut Royal Meteorologique de Belgique, Brussels.
**THE IMPORTANCE OF GUIDING ON THE MOTION OF A COMET IN ASTROMETRIC OBSERVATIONS**
Thierry Pauwels *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 451-454 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19220*#** Institut Royal Meteorologique de Belgique, Brussels.
**A NEW METHOD FOR ASTROMETRIC OBSERVATIONS OF ASTEROIDS**
Thierry Pauwels *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 455-458 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19224*#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).
**OBSERVATIONS OF COMET LEVY 1990c IN THE (OI) 6300-A LINE WITH AN IMAGING FABRY-PEROT**
C. Debi Prasad, Klaus Jockers, H. Rauer, and E. H. Geyer (Observatorium Hoher List, Daun, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 477-480 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19226*#** Indian Inst. of Astrophysics, Bangalore.
**NARROW BAND PHOTOMETRY OF SELECTED ASTEROIDS**
R. Rajamohan and S. G. Bhargavi *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 487-491 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19230*#** Notre Dame Univ., IN.
**LONG SLIT SPECTROSCOPY OF NH2 IN COMETS HALLEY, WILSON, AND NISHIKAWA-TAKAMIZAWA-TAGO**
Terrence W. Rettig, Stephen C. Tegler, Susan Wyckoff (Arizona State Univ., Tempe.), Rodney Heyd (Arizona State Univ., Tempe.), Raylee Stathkis (Anglo-Australian Observatory, Epping.), and D. A. Ramsay (Herzberg Inst. of Astrophysics, Pentiction, British Columbia ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 505-508 Sponsored in part by NSF (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19231*#** Astronomical Observatory, Uppsala (Sweden).
**TWENTIETH CENTURY LIGHT CURVES AND THE NUCLEUS OF COMET P/TEMPEL 2**
Hans Rickman, Michel C. Festou (Observatoire de Midi-Pyresnees, Toulouse, France ), Gonzalo Tancredi, and L. Kamel *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 509-512 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19236*#** Tohoku Univ., Sendai (Japan). Geophysical Inst.
**MOSAIC CCD METHOD: A NEW TECHNIQUE FOR OBSERVING DYNAMICS OF COMETARY MAGNETOSPHERES**
T. Saito, H. Takeuchi, Y. Kozuba, S. Okamura (Tokyo Univ., Mitake, Japan), I. Konno (Southwest Research Inst., San Antonio, TX.), M. Hamabe (Tokyo Univ., Mitake, Japan ), T. Aoki, S. Minami (Osaka Univ., Japan ), and S. Isobe (Tokyo Univ., Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 529-532 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19237*#** Five-College Astronomy Dept., Amherst, MA. Dept. of Physics and Astronomy.
**SUBMILLIMETER MOLECULAR LINE OBSERVATIONS OF COMETARY LEVY (1990c)**
F. Peter Schloerb and Weiguo Ge *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 533-536 (For primary document see N93-19113 06-90)
(Grant NAGw-1483)
Avail: CASI HC A01/MF A04

**N93-19239*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**AUTOMATED DETECTION OF ASTEROIDS IN REAL-TIME WITH THE SPACEWATCH TELESCOPE**
James Vernon Scotti, T. Gehrels, and David L. Rabinowitz *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 541-544 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19241*#** Kharkov State Univ. (USSR). Astronomical Observatory.
**INTERPRETING ASTEROID PHOTOMETRY AND POLARIMETRY USING A MODEL OF SHADOWING AND COHERENT BACKSCATTERING**
Y. G. Shkuratov and Karri Muinonen (Lowell Observatory, Flagstaff, AZ.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 549-552 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19248*#** Southwest Research Inst., San Antonio, TX. Space Sciences Dept.
**A CCD SEARCH FOR DISTANT SATELLITES OF ASTEROIDS 3 JUNO AND 146 LUCINA**
S. Alan Stern and Edwin S. Barker (McDonald Observatory, Fort Davis, TX.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 577-581 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19257*#** Jamieson Science and Engineering, Inc., Felton, CA.
**HIGH RESOLUTION IMAGES OF P/TEMPEL 1 AND P/TEMPEL 2 CONSTRUCTED FROM IRAS SURVEY DATA**
Russell G. Walker, Humberto Campins (Florida Univ., Gainesville.), and Martin Schlapfer *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 617-620 (For primary document see N93-19113 06-90)
(Contracts NAS5-30772; NASw-1821)
Avail: CASI HC A01/MF A04

**N93-19259*#** Tokyo Univ. (Japan). National Astronomical Observatory.
**METEOR RADIANT MAPPING WITH MU RADAR**
Jun-Ichi Watanabe, Tsuko Nakamura (Kyoto Univ., Japan ), T. Tsuda (Kyoto Univ., Japan ), M. Tsutsumi (Kyoto Univ., Japan ), A. Miyashita, and M. Yoshikawa (Ministry of Posts and Telecommunications, Tokyo, Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 625-627 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19261*#** Smithsonian Astrophysical Observatory, Cambridge, MA.
**A NEW ACTIVITY INDEX FOR COMETS**
Fred L. Whipple *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 633-640 (For primary document see N93-19113 06-90)
(Grant NsG-7082)
Avail: CASI HC A02/MF A04

**N93-19421*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Tracking Systems and Applications Section.
**EVALUATION OF THE TABLE MOUNTAIN RONCHI TELESCOPE FOR ANGULAR TRACKING**
G. Lanyi, G. Purcell, R. Treuhaft, and A. Buffington (California Univ., San Diego.) *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 104-117 (For primary document see N93-19413 06-32)
(RTOP 310-10-60-90-03)
Avail: CASI HC A03/MF A03

**N93-19422*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Navigation Systems Section.
**DEEP-SPACE NAVIGATION APPLICATIONS OF IMPROVED GROUND-BASED OPTICAL ASTROMETRY**
G. W. Null, W. M. Owen, Jr., and S. P. Synnott *In its* The Telecommunications and Data Acquisition 15 Aug. 1992 p 118-127 (For primary document see N93-19413 06-32)
(RTOP 310-10-63-55-00)
Avail: CASI HC A02/MF A03

## 90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.

For related information see also *75 Plasma Physics*.

**N93-18164*#** Texas Univ., Austin. Dept. of Aerospace Engineering.
**ASTEROID EXPLORATION AND UTILIZATION: THE HAWKING EXPLORER**
Alan Carlson, Medha Date, Manny Duarte, Neil Erian, George Gafka, Peter Kappler, Scott Patano, Martin Perez, Edgar Ponce, and Brian Radovich et al 15 Dec. 1991 122 p
(Contract NASw-4435)
(NASA-CR-192027; NAS 1.26:192027) Avail: CASI HC A06/MF A02

The Earth is nearing depletion of its natural resources at a time when human beings are rapidly expanding the frontiers of space. The resources which may exist on asteroids could have enormous potential for aiding and enhancing human space exploration as well as life on Earth. With the possibly limitless opportunities that exist, it is clear that asteroids are the next step for human existence in space. This report comprises the efforts of NEW WORLDS, Inc. to develop a comprehensive design for an asteroid exploration/sample return mission. This mission is a precursor to proof-of-concept missions that will investigate the validity of mining and materials processing on an asteroid. Project STONER (Systematic Transfer of Near Earth Resources) is based on two utilization scenarios: (1) moving an asteroid to an advantageous location for use by Earth; and (2) mining an asteroids and transporting raw materials back to Earth. The asteroid explorer/sample return mission is designed in the context of both scenarios and is the first phase of a long range plane for humans to utilize asteroid resources. The report concentrates specifically on the selection of the most promising asteroids for exploration and the development of an exploration scenario. Future utilization as well as subsystem requirements of an asteroid sample return probe are also addressed. Author

**N93-18171*#** Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
**COMET NUCLEUS AND ASTEROID SAMPLE RETURN MISSIONS Final Report**
Jun. 1992 325 p
(Contract NASw-4435)
(NASA-CR-192055; NAS 1.26:192055) Avail: CASI HC A14/MF A03

Three Advanced Design Projects have been completed this academic year at Penn State. At the beginning of the fall semester the students were organized into eight groups and given their choice of either a comet nucleus or an asteroid sample return mission. Once a mission had been chosen, the students developed conceptual designs. These were evaluated at the end of the fall semester and combined into three separate mission plans, including a comet nucleus same return (CNSR), a single asteroid sample return (SASR), and a multiple asteroid sample return (MASR). To facilitate the work required for each mission, the class was reorganized in the spring semester by combining groups to form three mission teams. An integration team consisting of two members from each group was formed for each mission so that communication and information exchange would be easier among the groups. The types of projects designed by the students evolved from numerous discussions with Penn State faculty and mission planners at the Johnson Space Center Human/Robotic Spacecraft Office. Robotic sample return missions are widely considered valuable precursors to manned missions in that they can provide details about a site's environment and scientific value. For example, a sample return from an asteroid might reveal valuable resources that, once mined, could be utilized for propulsion. These missions are also more adaptable when considering the risk to humans visiting unknown and potentially dangerous locations, such as a comet nucleus. Author

**N93-18626#** Bonn Univ. (Germany). Hohen Mathematisch-Naturwissenschaftlichen Fakultaet.
**MODEL CALCULATIONS OF DUST RADIATION FROM GALACTIC AND EXTRAGALACTIC SOURCES BY CONSIDERING POLYCYCLIC AROMATIC HYDROCARBONS Ph.D. Thesis [MODELLRECHNUNGEN VON STAUBSTRAHLUNG GALAKTISCHER UND EXTRAGALAKTISCHER QUELLEN UNTER BERUECKSICHTIGUNG VON POLYZYKLISCHEN AROMATISCHEN HYDROKARBONATEN]**
Ralf Siebenmorgen 1991 169 p In GERMAN
(ETN-93-92729) Avail: CASI HC A08/MF A02

The role of Polycyclic Aromatic Hydrocarbons (PAH) in short wavelength extinction and in the infrared emission of the interstellar medium is examined. A dust model which considers big grains of silicate and glassy carbon, small graphite particles and PAH, is presented. An efficient numerical method was achieved to solve the equation of radiative transfer in dense spherical dusty objects with particular consideration of PAH: the emission from centrally heated opaque clouds was calculated and the results were compared with

former models. To access the validity of the dust model, it was applied to the infrared emission from various astrophysical objects, such as reflection nebulae, planetary nebulae, active galactic nuclei, H II regions and the diffuse interstellar medium in the solar neighborhood. The influence of the model parameters, such as the atom number in PAH molecules and clusters and the variation of star temperature, is discussed. It is shown that in areas of harsh ultraviolet fields, the small particles reduce the temperature of the big grains by more than 15 percent compared to the calculations of former models. ESA

**N93-18992*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**EXTREME ULTRAVIOLET EXPLORER. LONG LOOK AT THE NEXT WINDOW**
Stephen P. Maran [1991] 26 p Original contains color illustrations
(NASA-TM-108618; NAS 1.15:108618) Avail: CASI HC A03/MF A01; 23 functional color pages

The Extreme Ultraviolet Explorer (EUVE) will map the entire sky to determine the existence, direction, brightness, and temperature of thousands of objects that are sources of so-called extreme ultraviolet (EUV) radiation. The EUV spectral region is located between the x-ray and ultraviolet regions of the electromagnetic spectrum. From the sky survey by EUVE, astronomers will determine the nature of sources of EUV light in our galaxy, and infer the distribution of interstellar gas for hundreds of light years around the solar system. It is from this gas and the accompanying dust in space that new stars and solar systems are born and to which evolving and dying stars return much of their material in an endless cosmic cycle of birth, death, and rebirth. Besides surveying the sky, astronomers will make detailed studies of selected objects with EUVE to determine their physical properties and chemical compositions. Also, they will learn about the conditions that prevail and the processes at work in stars, planets, and other sources of EUV radiation, maybe even quasars. The EUVE mission and instruments are described. The objects that EUVE will likely find are described. Author

**N93-19113*#** Lunar and Planetary Inst., Houston, TX.
**ASTEROIDS, COMETS, METEORS 1991**
Alan W. Harris, ed. and Edward Bowell, ed. 1992 497 p Conference held in Flagstaff, AZ, 24-28 Jun. 1991
(Contract NASw-4574)
(NASA-CR-191879; NAS 1.26:191879; ISBN-0-942862-07-04) Avail: CASI HC A21/MF A04

Papers from the conference are presented and cover the following topics with respect to asteroids, comets, and/or meteors: interplanetary dust, cometary atmospheres, atmospheric composition, comet tails, astronomical photometry, chemical composition, meteoroid showers, cometary nuclei, orbital resonance, orbital mechanics, emission spectra, radio astronomy, astronomical spectroscopy, photodissociation, micrometeoroids, cosmochemistry, and interstellar chemistry. For individual titles, see N93-19114 through N93-19272.

**N93-19114*#** Hoshi-no-Hiroba, Odawara (Japan).
**LIGHT CURVE AND FAN-SHAPED COMA OF COMET P/TEMPEL 2 IN 1988-1989**
Hiroki Akisawa, Mitsunori Tsumura (Wakayama City Children's Science Center, Japan ), Akimasa Nakamura, and Jun-Ichi Watanabe (Tokyo Astronomical Observatory, Mitaka, Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 1-4 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Visual and Photographic Monitoring observations of comet P/Tempel 2 were carried out by a Japanese amateur group 'Hoshi-no-Hiroba' in 1988-1989. We analyzed the light curve and the time variation of the fan-shaped coma. The light curve was asymmetric to the perihelion passage. The fan angle in September-October was wider than that in December. The direction of the fan generally coincided with Sekanina's prediction (1988). Author

**N93-19115*#** Engelhardt Astronomical Observatory (USSR).
**ABOUT DISTRIBUTION AND ORIGIN OF THE PECULIAR GROUP OF SPORADIC METEORS**
V. V. Andreev *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 5-8 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A particular group of sporadic meteors are picked out from analysis of meteor catalogs derived from results of radar observations in Mogadisho and Kharkov. The semi-major axes are equal or more than 1.73 AU and inclinations of orbits are equal or more than 90 degrees for these meteors. The distributions of radiants, velocities, and elements of orbits were derived. The probable source of meteor bodies of this peculiar group is the long-period comets, in particular, the comets of the Kreutz's group. Author

**N93-19116*#** Engelhardt Astronomical Observatory (USSR).
**PHOBOS AND DEIMOS ARE SOURCES OF METEOROIDS**
V. V. Andreev and Oleg I. Belkovich *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 9-15 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

Data of Pioneer 10 meteoroid penetration detectors were revised taking into account the orientation of detectors and the spacecraft velocity relative to the sporadic meteor flux. The meteor flux density increases as an exponent to the orbit of Mars for two times for the particles with masses greater than 10(exp -6) g and six times for the particles with masses greater than 10(exp -12) - 10(exp -9) g then decreases after the orbit. Ejections of secondary meteoroid particles from surfaces of Phobos and Deimos are a possible explanation for the increase in meteoroid flux. Author

**N93-19117*#** Engelhardt Astronomical Observatory (USSR).
**DETERMINATION OF METEOR FLUX DISTRIBUTION OVER THE CELESTIAL SPHERE**
V. V. Andreev, O. I. Belkovich, T. K. Filimonova (Kazan State Univ., USSR), and V. V. Sidorov (Kazan State Univ., USSR) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 17-22 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

A new method of determination of meteor flux density distribution over the celestial sphere is discussed. The flux density was derived from observations by radar together with measurements of angles of arrival of radio waves reflected from meteor trails. The role of small meteor showers over the sporadic background is shown. Author

**N93-19118*#** Academy of Sciences of the Tajik SSR, Doushanbe. Inst. of Astrophysics.
**FRAGMENTATION AND DENSITIES OF METEOROIDS**
Pulat B. Babadzhanov *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 23-26 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Photographic observations of meteors carried out in Dushanbe by the method of instantaneous exposure have shown clearly that meteoroids entering the Earth's atmosphere are subjected to different types of fragmentation. The quasi-continuous fragmentation of meteoroids is mostly widespread. Using the physical theory of meteors which takes into account the quasi-continuous fragmentation of meteoroids and on the basis of light curves of meteors the densities of meteoroids of different streams have been determined. The results enable us to conclude that the densities of meteoroids are over an order of magnitude higher than they have been assumed before. Moreover they are close to the densities of carbonaceous and ordinary chondrites. Author

**N93-19119*#** Academy of Sciences of the Tajik SSR, Doushanbe. Inst. of Astrophysics.
**P/MACHHOLZ 1986 8 AND QUADRANTID METEOROID STREAM. ORBITAL EVOLUTION AND RELATIONSHIP**
Pulat B. Babadzhanov and Y. V. Obrubov *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 27-32 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

The evolution of the P/Machholz's meteoroid stream was simulated. It shows that this stream may produce eight meteor showers. There are the known observed meteor showers such as the Quadrantids, Ursids, Northern and Southern delta-Aquarids, Daytime Arietids, and alpha-Cetids. A

satisfactory agreement of the theoretical and observed geocentric radiants and orbits allows one to conclude that the above showers could have been resulted from the decay of the P/Machholz nucleus. The age of the stream is estimated to be 7.5 millennia. Author

**N93-19120*#** Canterbury Univ., Christchurch (New Zealand). Dept. of Physics.
**RADAR METEOR ORBITAL STRUCTURE OF SOUTHERN HEMISPHERE COMETARY DUST STREAMS**
W. Jack Baggaley and Andrew D. Taylor *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 33-36 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The Christchurch, New Zealand meteor orbit radar (AMOR) with its high precision and sensitivity, permits studies of the orbital fine structure of cometary streams. PC generated graphics are presented of data on some Southern Hemisphere Streams. Such data can be related to the formation phase and subsequent dynamical processes of dust streams. Author

**N93-19121*#** Canterbury Univ., Christchurch (New Zealand). Dept. of Physics.
**A SOUTHERN HEMISPHERE RADAR METEOR ORBIT SURVEY**
W. Jack Baggaley, Duncan I. Steel, and Andrew D. Taylor *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 37-40 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A meteor radar system has been operated on a routine basis near Christchurch, New Zealand, to determine the orbits of Earth-impacting interplanetary dust and meteoroids. The system sensitivity is +13 visual magnitude, corresponding to approximately 100 micron sized meteoroids. With an orbital precision of 2 degrees in angular elements and 10 percent in orbital energy (1/a), the operation yields an average of 1500 orbits daily with a total to date in excess of 10(exp 5). The use of pc's and automated data reduction permit the large orbital data sets we collect to be routinely reduced. Some illustrative examples are presented of the signal formats/processing and the results of data reduction, giving the individual orbital elements and hence the overall distributions. Current studies include the distribution of dust in the inner solar system; the influx of meteoroids associated with near-Earth asteroids; and the orbital structure existing in comet-produced streams. Author

**N93-19122*#** Catania Astrophysical Observatory (Italy).
**ION PRODUCED COMETARY ORGANIC CRUST**
G. Antonio Baratta and G. Strazzulla (Catania Univ., Italy ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 41-44 Sponsored by Italian Space Agency (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

For several years many experimental results have been obtained on the chemical and physical changes induced by ion and electron irradiation of materials with a view to their Astrophysical relevance. Among the studied effects, one of particular interest is the formation of an organic refractory residue left over after ion irradiation and warming-up at room temperature. We call this residue IPHAC (ion produced hydrogenated amorphous carbon). Although 'in situ' infrared spectroscopy points out the formation of new molecular species during bombardment at low temperature, it is not clear if IPHAC is already formed or if its formation is triggered by temperature increase during warming-up of the irradiated target. Since Raman Spectroscopy is a technique particularly suitable for the analysis of carbonaceous materials, we have thought and build-up an experimental apparatus to obtain Raman Spectra of frozen hydrocarbons during ion irradiation. The present experimental results point out clearly to the formation of IPHAC already at low T and low energy deposition (approximately equal to a few eV/C-atom). Author

**N93-19123*#** Kharkov State Univ. (USSR). Astronomical Observatory.
**ASTEROIDS WITH UNUSUAL LIGHTCURVES: 14 IRENE AND 51 NEMAUSA**
I. N. Belskaya and A. N. Dovgopol (Main Astronomical Observatory, Kiev, USSR ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 45-48 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Some asteroids with peculiar light curves were chosen for more detail investigation. We present the first results of that study. Observations were obtained in 1989 and 1990 using the 70-cm telescope of Kharkov Observatory; the 40-cm telescope of Abastumani Observatory (Georgia), and the 60-cm telescope of the Main Astronomical Observatory of Ukrainian Academy of Sciences (Mt. Majdanak, Middle Asia). Observations and their reduction were carried out in a standard way. The aspect data, absolute magnitude of primary maximum, and lightcurve amplitude are given. Author

**N93-19124*#** National Optical Astronomy Lab. Tucson, AZ.
**LOW COST MISSIONS TO EXPLORE THE DIVERSITY OF NEAR EARTH OBJECTS** **c12**
Michael J. S. Belton and Alan Delamere (Ball Aerospace Systems Div., Boulder, CO.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 49-55 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

We propose a series of low-cost flyby missions to perform a reconnaissance of near-Earth cometary nuclei and asteroids. The primary scientific goal is to study the physical and chemical diversity in these objects. The mission concept is based on the Pegasus launch vehicle. Mission costs, inclusive of launch, development, mission operations, and analysis are expected to be near $50 M per mission. Launch opportunities occur in all years. The benefits of this reconnaissance to society are stressed. Author

**N93-19125*#** Observatoire du Mont-Gros, Nice (France).
**SIMULATED FAMILIES: A TEST FOR DIFFERENT METHODS OF FAMILY IDENTIFICATION**
Philippe Bendjoya, Alberto Cellino (Osservatorio Astronomico, Turin, Italy ), Claude Froeschle, and Vincenzo Zappala (Osservatorio Astronomico, Turin, Italy ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 57-60 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A set of families generated in fictitious impact events (leading to a wide range of 'structure' in the orbital element space have been superimposed to various backgrounds of different densities in order to investigate the efficiency and the limitations of the methods used by Zappala et al. (1990) and by Bendjoya et al. (1990) for identifying asteroid families. In addition, an evaluation of the expected interlopers at different significance levels and the possibility of improving the definition of the level of maximum significant of a given family were analyzed. Author

**N93-19126*#** Observatoire du Mont-Gros, Nice (France).
**THE USE OF THE WAVELET CLUSTER ANALYSIS FOR ASTEROID FAMILY DETERMINATION**
Phillippe Benjoya, E. Slezak, and Claude Froeschle *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 61-64 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The asteroid family determination has been analysis method dependent for a longtime. A new cluster analysis based on the wavelet transform has allowed an automatic definition of families with a degree of significance versus randomness. Actually this method is rather general and can be applied to any kind of structural analysis. We will rather concentrate on the main features of the method. The analysis has been performed on the set of 4100 asteroid proper elements computed by Milani and Knezevic (see Milani and Knezevic 1990). Twenty one families have been found and influence of the chosen metric has been tested. The results have beem compared to Zappala et al.'s ones (see Zappala et al 1990) obtained by the use of a completely different method applied to the same set of data. For the first time, a good overlapping has been found between both method results, not only for the big well known families but also for the smallest ones. Author

**N93-19127*#** California Univ., La Jolla. Space Inst.
**BIAS CORRECTION FACTORS FOR NEAR-EARTH ASTEROIDS**
Gretchen K. Benedix, Lucy Ann McFadden, Esther M. Morrow, and Marina N. Fomenkova (Academy of Sciences, USSR, Moscow ) *In* Lunar and

Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 65-68 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Knowledge of the population size and physical characteristics (albedo, size, and rotation rate) of near-Earth asteroids (NEA's) is biased by observational selection effects which are functions of the population's intrinsic properties and the size of the telescope, detector sensitivity, and search strategy used. The NEA population is modeled in terms of orbital and physical elements: a, e, i, omega, Omega, M, albedo, and diameter, and an asteroid search program is simulated using actual telescope pointings of right ascension, declination, date, and time. The position of each object in the model population is calculated at the date and time of each telescope pointing. The program tests to see if that object is within the field of view (FOV = 8.75 degrees) of the telescope and above the limiting magnitude (V = +1.65) of the film. The effect of the starting population on the outcome of the simulation's discoveries is compared to the actual discoveries in order to define a most probable starting population. Author

**N93-19128*#** Observatoire du Mont-Gros, Nice (France).
**STOCHASTICITY OF COMET P/SLAUGHTER-BURNHAM**
Daniel Benest and R. Gonczi *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 69-72 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Three comets are now known to be at or near the 1/1 resonance with Jupiter: P/Slaughter-Burnham, P/Boethin and the newly discovered P/Ge-Wang. Although details of the individual orbits differ, the three comets have very similar dynamical behavior: their orbits show many transitions between the different types of resonant motion (satellite libration, anti-satellite libration, and circulating motion). The stochastic character of such cometary orbits, mainly due to encounters with Jupiter is investigated using Lyapunov Characteristic Indicators. For each comet of the group, we study the influences on the stochasticity of initial eccentricity, inclination, longitude of node, and l-l(sub J) (mean longitude of comet minus mean longitude of Jupiter). We present here our first results for P/Slaughter-Burnham.
Author

**N93-19129*#** Observatoire de Paris (France). Section de Meudon.
**OBSERVATIONS OF OH IN COMET LEVY WITH THE NANCAY RADIO TELESCOPE** **c89**
Dominique Bockelee-Morvan, P. Colom, Jacques Crovisier, E. Gerard, and G. Bourgois *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 73-76 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Due to extremely favorable excitation conditions, comet Levy (1990c) exhibited in August-September 1990 the strongest OH 18-cm signal ever recorded in a comet at the Nancay radio telescope. This unique opportunity was used to measure the OH satellite lines at 1612 and 1721 MHz, to perform extensive mapping of the OH radio emission and to make a sensitive evaluation of the cometary magnetic field, of the H2O outflow velocity and of the OH production rate. Author

**N93-19130*#** Remeis Sternwarte, Bamberg (Germany).
**COMET P/TEMPEL: SOME HIGHLIGHTS AND CONCLUSIONS FROM THE 1988 APPARITION**
Hermann Boehnhardt (Mathematischer Beratungs- und Programmierungsdienst G.m.b.H., Dormund, Germany ), A. Baer, and L. Massonne (Mathematischer Beratungs- und Programmierungsdienst G.m.b.H., Dormund, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 77-80 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

From the brightness development and a sequence of imaging observations of the coma activity onset of comet P/Tempel 2 in 1988, it is concluded that there might have happened eruptive events of strong dust and gas outbursts during May and June 1988. A comparison of dust coma modeling calculations with CCD observations of the coma widely confirms Sekanina's nucleus model for the comet. Author

**N93-19131*#** Mathematischer Beratungs- und Programmierungsdienst G.m.b.H., Dormund (Germany).
**COMA IMAGING OF COMET P/BRORSEN-METCALF AT CALAR ALTO IN LATE JULY TO MID AUGUST 1989**
Hermann Boehnhardt (Remeis Sternwarte, Bamberg, Germany ), Vladimir Vanysek (Karlova Univ., Prague, Czechoslovakia ), K. Birkle (Max-Planck-Inst. fuer Astronomie, Heidelberg, Germany ), and U. Hopp (Max-Planck-Inst. fuer Astronomie, Heidelberg, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 81-84 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Comet P/Brorsen-Metcalf was observed on 1989/07/28+30 and on 1989/08/04+12(+14) with the 3.5 m telescope and the 0.8 m Schmidt camera at Calar Alto/Spain. The images exhibit a narrow plasma tail pointing into anti-solar direction. On 1989/07/30 a triple tail was found which can be interpreted as tail ray event. The coma isophotes show prominent asymmetries with the nucleus located on the tailward side of the isophote foci and with a slightly higher brightness in the Northern Hemisphere of the coma. A strong curved jet feature was detected in the coma on 1989/07/30. The jet extended at least 30,000 km into the sunward coma hemisphere. The rotation period of about 1.3 days, estimated from the curvature of the coma jet, needs verification by other observations.
Author

**N93-19132*#** Southwest Research Inst., San Antonio, TX. Space Sciences Div.
**A PRELIMINARY MODEL OF THE COMA OF 2060 CHIRON**
Daniel C. Boice, I. Konno, S. Alan Stern, and Walter F. Huebner *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 85-88 (For primary document see N93-19113 06-90)
(Grants NAGw-2370; NAGw-2205)
Avail: CASI HC A01/MF A04

We have included gravity in our fluid dynamic model with chemical kinetics of dusty comet comae and applied it with two dust sizes to 2060 Chiron. A progress report on the model and preliminary results concerning gas/dust dynamics and chemistry is given. Author

**N93-19133*#** Sheffield Univ. (England). Dept. of Physics.
**CCD IMAGING OF THE INNER COMA JETS OF COMET P/HALLEY**
James Boswell and David W. Hughes *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 89-92 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We analyze the inner coma section of a CCD image of comet P/Halley taken at 1807 UT on 13 March 1986 using a C2 filter (wavelength 5000 to 5200A, half maximum) with the 3.8 m Anglo Australian Telescope at Siding Springs, Australia. Atmospheric turbulence leads to a spreading of the image detail and this produces a blander image of the inner coma region with a slower radial decrease of brightness in comparison to the unaffected image. We remove this smearing by utilizing the point spread function of a star on the same CCD image. Jets were then revealed by removing the average background. Analysis of the jet structure enabled us to estimate the lower limit of the parent molecule velocity. This is found to be 0.3 km s(exp -1). Author

**N93-19134*#** Colorado Univ., Boulder. Lab. for Astrophysics and Space Physics.
**INITIAL OVERVIEW OF DISCONNECTION EVENTS IN HALLEY'S COMET 1986**
John C. Brandt, Cora E. Randall, M. Snow, and Y. Yi *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 93-96 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We present an initial overview of the disconnection events (DE's) in Comet Halley in 1986. Although disconnection events are arguably the most spectacular of all dynamic comet phenomena, the mechanisms by which they occur are not fully understood. It is generally believed that the solar wind plays a major role in determining when disconnection events occur, but the details of the solar wind/cometary interactions responsible for initiating the tail disconnection are still under debate. The three most widely accepted models are: (1) high speed streams in the solar wind cause the tail to disconnect due to pressure effects; (2) decreased production

of cometary ions in a high speed stream allows magnetic field to slip away from the comet; and (3) the tail disconnects after frontside reconnection of the interplanetary magnetic field (IMF) as the comet crosses a magnetic field sector boundary. We find that the front-side magnetic reconnection model is the best explanation for the DE's we have considered. Author

**N93-19135*#** California Univ., Berkeley. Dept. of Astronomy.
**HIGH-RESOLUTION OBSERVATIONS OF THE SPATIAL AND VELOCITY DISTRIBUTION OF COMETARY HYDROGEN**
Michael E. Brown and Hyron Spinrad *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 97-100 Sponsored in part by NSF (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We have obtained high velocity and spatial resolution long-slit H alpha spectra of comets Austin (1989c1) and Levy (1990c). Spectra of both comets clearly show the existence of a low velocity thermalized component of hydrogen gas. The amount of slow hydrogen is estimated for comet Austin. The Levy spectrum shows an unusual high-velocity spatially-confined blob of hydrogen emission of unknown origin. Author

**N93-19136*#** Cornell Univ., Ithaca, NY.
**DEBRIS ABOUT ASTEROIDS: WHERE AND HOW MUCH?**
Joseph A. Burns and Douglas P. Hamilton *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 101-108 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

We summarize several recent findings on the size and shape of the region within which material can stably orbit an asteroid. If the asteroid (with assumed density 2.38 g/cu cm) circles the Sun at 2.55 AU, co-planar prograde material will remain trapped whenever started on unperturbed circular orbits at less than about 220 R(sub A) (asteroid radii); co-planar retrograde particles are stable out twice as far. Our 3-D stability surface, which encloses several hundred numerically calculated orbits that start with various inclinations, is shaped like a sphere with its top and bottom sliced off; its dimensions scale like the Hill radius =(mu/3)(exp 1/3)R, where mu is the asteroid-to-solar mass ratio and R is the asteroid's orbital radius. If the asteroid moves along an elliptical orbit, a fairly reliable indicator of the dimensions of the hazard zone is the size of its Hill sphere at the orbit's pericenter. Grains with radii less than a few mm will be lost through the action of radiation forces which can induce escape or cause collisions with the asteroid on times scales of a few years; interplanetary micrometeoroids produce collisional break-up of these particles in approximately 10(exp 4) yrs. The effects of Jupiter and of asteroids that pass close to the target asteroid allow particles to diffuse from the system, again shrinking the hazard zone. None of the considered sources-primordial formation, debris spalled off the asteroid during micrometeoroid impact, captured interplanetary particles, feeder satellites, etc., seem capable of densely populating distant orbits from the asteroid. No certain detections of debris clouds or of binary asteroids have been made. Thus, it seems highly unlikely that a spacecraft fly-by targeted at 100 R(sub A) from the asteroid over its orbital pole would encounter any material. Author

**N93-19137*#** Ceskoslovenska Akademie Ved, Ondrejov.
**GROSS-FRAGMENTATION OF METEOROIDS AND BULK DENSITY OF GEMINIDS FROM PHOTOGRAPHIC FIREBALL RECORDS**
Zdenek Ceplecha and R. E. McCrosky (Smithsonian Astrophysical Observatory, Cambridge, MA.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 109-112 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The explicit solution of the drag and ablation equations of a single nonfragmenting meteoroid moving in any actual atmosphere was published several years ago. The solution yields the theoretical relation of I, the distance flown by the meteoroid in its trajectory, as a function of time, t, assuming that the height, h, is a known function of I. The photographic records of meteors and fireballs are coded by time marks, using a rotating shutter or a similar device to break the moving image. Time is, thus, the independent variable and for each time mark on a meteoroid trajector, the observed distance along the trajectory, I sub obs, as well as the double- or multiple- station photographs of the same meteoroid. Applying this solution to all available Prairie Network (PN) fireball-records, we recognized that the majority of them gave good solutions with standard deviations somewhat bigger than the intrinsic geometrical precision of the data. We also noticed that, on an average, previous methods of evaluation of the meteoroid velocities (interpolation polynomials, numerical differenciation of the observed I sub obs) used up to only several tens of percent of the intrinsic precision of the PN observational data. When residuals of these solutions, i.e. I sub obs - I sub com, were represented as a function of time for about 75 percent of solutions. The remaining 25 percent of residuals showed systematic changes with time exceeding one standard deviation. We tried to explain these systematic time course of residuals by using different meteoroids first computed theoretically and then analyzed by the same model as the natural PN fireballs were. The conclusion of these model computations is that systematic time changes of residuals in the nonfragmenting model exceeding one standard of deviation are caused by sudden gross fragmentation at one or more trajectory points. Thus, we generalized the explicit solution of the drag and ablation equations of a single nonfragmenting meteoroid by allowing for one or more points, where sudden gross fragmentation can occur. Using this generalized solution, the distances along the meteoroid trajectory can be computed for any choice of input parameters and compared with the observed distances flown by the meteoroid. For the most precise and long fireball trajectories, the least-squares solution can, thus, yield the initial velocities, the ablation coefficients, the dynamical masses, the positions of gross-fragmentation points, and the terminal mass. At a gross-fragmentation point, the ratio of the main mass to all the remaining fragments can be compared with the dynamic mass determined from our gross-fragmentation model and, thus, the meteoroid bulk density can be evaluated. We applied the gross-fragmentation model to sever PN fireballs showing time changes of residuals, and we recognized that, in all these cases, the new computed bulk densities of meteoroids resulted higher in comparison with the meteoroid densities determined with the non-gross-fragmentation model. Other aspects of the study are discussed. Author

**N93-19138*#** Observatoire du Mont-Gros, Nice (France).
**LIFETIME OF BINARY ASTEROIDS VERSUS GRAVITATIONAL ENCOUNTERS AND COLLISIONS**
Bertrand Chauvineau, Paolo Farinella (Pisa Univ., Italy ), and F. Mignard (Pisa Univ., Italy ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 113-116 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We investigate the effect on the dynamics of a binary asteroid in the case of a near encounter with a third body. The dynamics of the binary is modeled as a two-body problem perturbed by an approaching body in the following ways: near encounters and collisions with a component of the system. In each case, the typical value of the two-body energy variation is estimated, and a random walk for the cumulative effect is assumed. Results are applied to some binary asteroid candidates. The main conclusion is that the collisional disruption is the dominant effect, giving lifetimes comparable to or larger than the age of the solar system. Author

**N93-19139*#** Kiev State Univ. (USSR). Astronomical Observatory.
**THE FIRST IDENTIFICATION OF C2 EMISSION BANDS IN COMET SCORICHENKO-GEORGE (1989e1) SPECTRUM**
Klim I. Churyumov and G. F. Chorny (Main Astronomical Observatory, Kiev, USSR ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 117-120 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Wave lengths from 360 emissions within the spectral range lambda lambda 3380-6290 A in the spectrum of the comet Scorichenko-George, obtained with the help of the TV spectral scanner of a 6-meter reflector BTA (in Special AO) have been determined. The CN, C2, C3, NH, CH, CO, Na, NH2, N2(+), CO(+), CO2(+), H2O(+), and C2(-) emissions have been identified. For the first time, it has been shown that emissions of C2(-) (the transitions 0-0, 0-1, et al.) in the cometary spectrum possibly exist. Molecular ions C2(-) column density with cross-section 1 sq cm is N = 1.44 10(exp -12) cm(exp -2) and their upper limits of gas C2(-) productivity is Q(C2(-)) = 2 10(exp 28) c(exp -1). Author

**N93-19140*#** Kiev State Univ. (USSR). Astronomical Observatory.
**INFLUENCE OF SOLAR ACTIVITY UPON LIGHT CURVES OF COMETS P/HALLEY (1986 3) AND P/CHURYUMOV-GERASIMENKO (1982 8)**
Klim I. Churyumov and V. S. Filonenko (Kharkov State Univ., USSR ) *In*

Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 121-124 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

It is shown that the comet P/Halley's (1986 3) total magnitudes correlate with changes in the solar activity indices and the solar wind velocity. A statistically reliable correlation between the outbursts of brightness and magnitude variations of the short-period comet Churyumov-Gerasimenko (1982 8) and the level of the solar activity has been discovered. Author

**N93-19141*#** Kiev State Univ. (USSR). Dept. of Astronomy.
**PLASMA-BEAM INSTABILITIES IN COMETARY IONOSPHERES**
Klim I. Churyumov, N. Ya. Kotsarenko, G. V. Lizunov, and O. P. Verkhoglyadova *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 125-128 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

It is shown that the interaction between the solar wind flux and the cometary ionosphere leads to the excitation of ion sound, whistler, electron-cyclotron, low hybrid, and magnetohydrodynamic waves. We investigated the frequency spectrum and found linear-increasing increments and lengths of excited waves. Author

**N93-19142*#** Observatoire de Besancon (France).
**DUST AND GAS JETS: EVIDENCE FOR A DIFFUSE SOURCE IN HALLEY'S COMA**
Jacques Clairemidi, Philippe Rousselot, F. Vernotte, and Guy Moreels *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 129-132 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The distribution of dust-scattered intensity in Halley's inner coma is measured with the Vega three-channel spectrometer at three selected wavelengths: 377, 482, and 607 nm. The variation along a cometo-centric radius may be described by a p(sup -s) law where p is the distance between nucleus and optical axis and s is an exponent which is equal to 1 except in an intermediate 3000 less than p less than 7000 km region where s = 1.5. The shape of the radial distribution may be explained with a model including solar radiation pressure effect and quantum scattering efficiencies calculated from Mie theory. Monochromatic images inside an angular sector having its apex at the nucleus show evidence of two dust jets which extend to 40,000 Km. The pixel-to-pixel ratio of two images of dust intensity at 377 and 482 nm shows that the scattered intensity presents an excess of blue coloration in a zone located around the jets between 10,000 and 25,000 km. This coloration is interpreted as being due to a population of sub-micronic grains which result of the fragmentation of dust particles transported in the jets. It is suggested that the diffuse source where an additional quantity of CO was detected might be connected with the presence of a dust jet. In the present scheme, grain particles with a size of several micron or 10 micron would be transported inside a dust jet to distances of several 10,000 km where they would suffer fragmentation and produce sub-micronic particles and a release of gas which would be at the origin of the diffuse source. Author

**N93-19143*#** Observatoire de Paris (France). Section de Meudon.
**OBSERVATIONS OF COMETARY PARENT MOLECULES WITH THE IRAM RADIO TELESCOPE** **c89**
P. Colom, D. Despois (Bordeaux Univ., France ), G. Paubert (Instituto de Radioastronomia, Granada, Spain ), D. Bockelee-Morvan, and Jacques Crovisier *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 133-136 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Several rotational transitions of HCN, H2S, H2CO, and CH3OH were detected in comets P/Brorsen-Metcalf 1989 X, Austin (1989c1) and Levy (1990c) with the Institute for Millimeter Radioastronomy (IRAM) 30-m radio telescope. This allows us to determine the production rates of these molecules and to probe the physical conditions of the coma. Author

**N93-19144*#** Observatoire de Paris (France). Section de Meudon.
**RADIO SPECTROSCOPY OF COMETS: RECENT RESULTS AND FUTURE PROSPECTS** **c89**
Jacques Crovisier *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 137-140 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We review the recent results of cometary radio spectroscopy (since 1988). Successful observations with several instruments yielded the detection of new molecular species, the simultaneous investigations of several rotational transitions of the same molecule, and mapping of the coma. Author

**N93-19145*#** Cunningham (Clifford J.), Kitchener (Ontario).
**THE GREAT ASTEROID NOMENCLATURE CONTROVERSY OF 1801**
Clifford J. Cunningham *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 141-143 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

With the almost complete neglect of 19th century asteroid research by professional historians of science, it is scarcely surprising that great gaps exist in our knowledge of that important field. This paper focuses on issue of naming the first asteroid. This seemingly innocuous issue assumed great importance because many believed the object discovered by Giuseppe Piazzi at Palermo Observatory to be the eighth primary planet of the solar system. Author

**N93-19146*#** Astronomical Observatory, Uppsala (Sweden).
**THE ORBITAL EVOLUTION OF REAL ASTEROIDS NEAR THE 4:1 MEAN-MOTION RESONANCE WITH JUPITER**
Mats Dahlgren, Gerhard Hahn (Manchester Univ., England ), C.-I. Lagerkvist, and M. Lundstroem *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 145-148 Sponsored in part by Science Research Council (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Numerical integrations of the orbits of ten asteroids with osculating elements near the 4:1 mean-motion resonance with Jupiter have been performed over 200,000 years into the future. A variety of orbital evolutions was found, depending on the start values of the semi-major axis. The orbit of asteroid 1983 RJ4, which lies almost exactly at the resonance center, experiences large variations in eccentricity, evolving into an Earth-crosser on a time-scale of a few 10(exp 4) years. This makes this region a potential source for Apollo objects and meteoritic material, although the width of the resonance region in semi-major axis seems to be very narrow. Author

**N93-19147*#** Technische Hochschule, Graz (Austria). Space Research Inst.
**INTERPLANETARY MAGNETIC FIELD CHANGES AND CONDENSATIONS IN COMET HALLEY'S PLASMA TAIL**
Magda Delva and K. Schwingenschuh *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 149-152 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

In a time-dependent three dimensional MHD simulation for cometary plasmas, Schmidt-Voigt (1989) could observe the formation of condensations in the plasma tail after a 90 degree change in the interplanetary magnetic field (IMF) sweeping over the comet. We investigated the IMF measurements of the Vega SC in the vicinity of the comet Halley for 90 degree changes in the clock angle and studied the relation between them and optical observations of condensations in the plasma tail. For the time interval 24 Feb. 86 to 14 Mar. 86, we could not find a correlation between such changes and the release of condensations from the cometary head. Author

**N93-19148*#** Florida Univ., Gainesville. Dept. of Astronomy
**THE ORIGIN AND EVOLUTION OF THE ZODIACAL DUST CLOUD**
Stanley F. Dermott, Daniel D. Durda, Bo A. S. Gustafson, S. Jayaraman, Y. L. Xu, R. S. Gomes (National Observatory, Rio de Janeiro, Brazil ), and P. D. Nicholson (Cornell Univ., Ithaca, NY.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 153-156 Sponsored in part by IBM (For primary document see N93-19113 06-90)
(Grants NAGw-1923; NAG9-440; NAG5-1725; NAGw-1257)
Avail: CASI HC A01/MF A04

We have now analyzed a substantial fraction of the IRAS observations of the zodiacal cloud, particularly in the 25 micron waveband. We have developed a gravitational perturbation theory that incorporates the effects of Poynting-Robertson light drag (Gomes and Dermott, 1992). We have also developed a numerical model, the SIMUL mode, that reproduces the

exact viewing geometry of the IRAS telescope and calculates the distribution of thermal flux produced by any particular distribution of dust particle orbits (Dermott and Nicholson, 1989). With these tools, and using a distribution of orbits based on those of asteroidal particles with 3.4 micron radii whose orbits decay due to Poynting-Robertson light drag and are perturbed by the planets, we have been able to: (1) account for the inclination and node of the background zodiacal cloud observed by IRAS in the 25 micron waveband; (2) relate the distribution of orbits in the Hirayama asteroid families to the observed shapes of the IRAS solar system dustbands; and (3) show that there is observational evidence in the IRAS data for the transport of asteroidal particles from the main belt to the Earth by Poynting-Robertson light drag. Author

**N93-19149*#** Osservatorio Astronomico, Turin (Italy).
**A PHOTOMETRIC SURVEY OF OUTER BELT ASTEROIDS** **c89**
M. DiMartino, M. Gonano-Beurer (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany ), Stefano Mottola (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany ), and G. Neukum (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 157-160 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Since 1989, we have been conducting a research program devoted to the study of the Trojans and outer belt asteroids (Hilda and Cybele groups), in order to characterize their rotational properties and shapes. As an outcome of several observational campaigns, we determined rotational periods and lightcurve amplitudes for 23 distant asteroids, using both CCD and photoelectric photometry. In this paper, we compare the rotational properties of main belt asteroids and Trojans, based on the preliminary results of this survey. Author

**N93-19150*#** Florida Univ., Gainesville. Dept. of Astronomy.
**MODELING OF ASTEROIDAL DUST PRODUCTION RATES**
Daniel D. Durda, Stanley F. Dermott, and Bo A. S. Gustafson *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 161-164 (For primary document see N93-19113 06-90)
(Grant NAGw-1923)
Avail: CASI HC A01/MF A04

The production rate of dust associated with the prominent Hirayama asteroid families and the background asteroidal population are modeled with the intent of using the families as a calibrator of mainbelt dust production. However, the dust production rates of asteroid families may be highly stochastic; there is probably more than an order of magnitude variation in the total area of dust associated with a family. Over 4.5 x 10(exp 9) years of collisional evolution, the volume (mass) of a family is ground down by an order of magnitude, suggesting a similar loss from the entire mainbelt population. Our collisional models show that the number of meteoroids deliverable to Earth also varies stochastically, but only by a factor of 2 to 3. Author

**N93-19151*#** Pisa Univ. (Italy). Dipt. di Matematica.
**FROM ASTEROID CLUSTERS TO FAMILIES: A PROPOSAL FOR A NEW NOMENCLATURE**
Paolo Farinella, Donald R. Davis (Planetary Science Inst., Tucson, AZ.), Alberto Cellino (Osservatorio Astronomico, Turin, Italy ), and Vincenzo Zappala (Osservatorio Astronomico, Turin, Italy ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 165-166 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Some confusion on the number, reliability, and characteristics of asteroid families is the result of using the single word 'family' for naming asteroid groupings identified in very different ways. Here we propose a new terminology which in our opinion would alleviate this problem. Author

**N93-19152*#** Pisa Univ. (Italy). Dipt. di Matematica.
**INJECTING ASTEROID FRAGMENTS INTO RESONANCES**
Paolo Farinella, R. Gonczi (Observatoire de la Cote d'Azur, Nice, France ), Christiane Froeschle (Observatoire de la Cote d'Azur, Nice, France ), and Claude Froeschle (Observatoire de la Cote d'Azur, Nice, France ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 167-170 (For primary document see N93-19113 06-90)
(Contract EEC-SC1-0011-C(GDF))
Avail: CASI HC A01/MF A04

We have quantitatively modeled the chance insertion of asteroid collisional fragments into the 3:1 and g = g(sub 6) resonances, through which they can achieve Earth-approaching orbits. Although the results depend on some poorly known parameters, they indicate that most meteorites and near-earth asteroids probably come from a small and non-representative sample of asteroids, located in the neighborhood of the two resonances. Author

**N93-19153*#** Johns Hopkins Univ., Baltimore, MD. Dept. of Physics and Astronomy.
**IUE OBSERVATIONS OF PERIODIC COMETS TEMPEL-2, KOPFF, AND TEMPEL-1** **c89**
Paul D. Feldman and Michel C. Festou (Observatoire de Midi-Pyresnees, Toulouse, France ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 171-174 (For primary document see N93-19113 06-90)
(Grant NsG-5393)
Avail: CASI HC A01/MF A04

We summarize the results of observations made between 10 Jun. - 18 Dec. 1988 with the International Ultraviolet Explorer (IUS) of comet P/Tempel-2 during its 1988 appearance. The derived water production rate and relative gas/dust ratio are compared with those of P/Halley, observed with IUE in 1985-86, and other potential Comet Rendezvous/Asteroid Flyby (CRAF) target comets, P/Kopff and P/Tempel-1, both observed with IUE in 1983. Author

**N93-19154*#** Southwest Research Inst., San Antonio, TX.
**WATER AND DUST PRODUCTION RATES IN COMET P/HALLEY DERIVED FROM ULTRAVIOLET AND OPTICAL OBSERVATIONS**
Michel C. Festou (Observatoire de Midi-Pyresnees, Toulouse, France ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 175-176 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We evaluate whether the activity of comet P/Halley is due solely to the presence of discrete active areas. We preliminarily conclude that the dark areas of the nucleus contribute to the formation of the coma. Author

**N93-19155*#** Southwest Research Inst., San Antonio, TX.
**THE GAS PRODUCTION RATE OF PERIODIC COMET D'ARREST**
Michel C. Festou (Observatoire de Midi-Pyresnees, Toulouse, France ), Paul D. Feldman (Johns Hopkins Univ., Baltimore, MD.), and Michael F. AHearn (Maryland Univ., College Park.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 177-182 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

Comet P/d'Arrest is a potential target for a rendezvous mission to a short period comet. Its light curve is rather peculiar, the comet being active only after perihelion passage. One apparition out of two is easy to observe from the ground. The 1995 apparition of the comet will offer a unique opportunity to characterize the outgassing properties of its nucleus. Author

**N93-19156*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**PRODUCTION RATES FOR COMET P/TEMPLE 2 FROM LONG SLIT CCD SPECTROSCOPY**
Uwe Fink and Michael Hicks *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 183-186 (For primary document see N93-19113 06-90)
(Grant NAGw-1549)
Avail: CASI HC A01/MF A04

Since comet P/Temple-2 is one of the potential targets for the CRAF (Comet Rendezvous Asteroid Flyby) mission, we obtained long slit spectroscopic data with our CCD spectrograph during its 1988 apparition. As the same spectrograph was extensively used for observations of P/Halley, this allowed a direct spectroscopic comparison between the two objects. Furthermore we could choose a P/Halley spectrum which was taken at a heliocentric distance very close to that of P/Temple-2. Finally, we could adjust the integration windows along the slit to compensate for the different

geocentric distances, so that roughly the same projected distance of the comets' comae was observed. The parameters for our observations are given. Author

**N93-19157*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**P/HALLEY: SPATIAL DISTRIBUTION AND SCALE LENGTHS FOR C2, CN, NH2, AND H2O**
Uwe Fink, Michael Combi (Michigan Univ., Ann Arbor.), and Michael A. DiSanti *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 187-189 Prepared in cooperation with Arizona Univ., Tucson (For primary document see N93-19113 06-90)
(Grants NAGw-1549; NAGw-1907)
Avail: CASI HC A01/MF A04

From P/Halley, long slit spectroscopic exposures on 12 dates, extending from Oct. 1985 to May 1986, spatial profiles were obtained for emissions by C2, CN, NH2, and OI ((sup 1)D). Examples of our derived spatial profiles are given. The qualitative trend of the scale lengths for the different species is nicely exemplified in this example. C2 has the longest parent scale length followed by CN and NH2. OI which tracks the parent H2O distribution is quite narrow but slightly wider than the continuum profile which has a center essentially indistinguishable from the stellar seeing disk. Comparison of C2 and CN also shows that C2 is falling off faster in the wings so that the daughter scale length of CN must be larger than that of C2. Author

**N93-19158*#** Queens Univ., Belfast (Northern Ireland). Dept. of Physics.
**SPECTROSCOPY OF D-TYPE ASTEROIDS** **c89**
Alan Fitzsimmons, Mats Dahlgren (Astronomical Observatory, Uppsala, Sweden ), C.-I. Lagerkvist (Astronomical Observatory, Uppsala, Sweden ), Per Magnusson (Westfield Coll., London, England ), and I. P. Williams (Westfield Coll., London, England ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 191-194 Sponsored in part by Science Research Council and Swedish Research Council (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We have performed a spectroscopic survey of 19 D-type asteroids. Comparison with previous photometry shows excellent agreement. Although the majority have similar colors to cometary nuclei, no cometary emission bands were present in any of the spectra. Absorption bands sporadically appearing were apparently due to stellar objects, and no features inherent to the asteroids were observed. Author

**N93-19159*#** State Univ. of New York, Plattsburgh. Dept. of Physics.
**ATMOSPHERIC ENTRY SURVIVAL OF LARGE MICROMETEORITES: IMPLICATIONS FOR THEIR SOURCES AND FOR THE COMETARY CONTRIBUTION TO THE ZODIACAL CLOUD**
George J. Flynn *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 195-199 (For primary document see N93-19113 06-90)
(Grant NAG9-469)
Avail: CASI HC A01/MF A04

Atmospheric entry heating simulations indicate that a large fraction of the micrometeorites larger than 100 microns in diameter which survive atmospheric entry must have entered the Earth's atmosphere with velocities very near the Earth's escape velocity. Thus, these particles must have been captured by Earth from heliocentric orbits with small eccentricities and low inclinations, indicating a main-belt asteroidal source. Space exposure ages measured on these large micrometeorites are also consistent with a main-belt asteroidal source. However, dynamical calculations have previously indicated that particles larger than 100 microns in diameter were likely to be destroyed by catastrophic collisions in the time required for orbital evolution from the main-belt to Earth capture by Poynting-Robertson drag. The absence of a large amount of collisional debris in the less than 50 microns size range indicates these large micrometeorites are not the few, rare survivors of a mostly collisionally disrupted population. The measured space exposure ages, which are about an order of magnitude larger than their calculated catastrophic collision lifetimes, confirm the survival of these large micrometeorites for times much longer than the calculated catastrophic collision lifetimes. Since collisions with cometary dust less than 20 microns in size were expected to be the major contributor to the collisional destruction of these larger particles, the contribution of cometary material to the zodiacal cloud is likely to be much smaller than previously believed. Author

**N93-19160*#** Observatoire du Mont-Gros, Nice (France).
**POLYNOMIAL APPROXIMATION OF POINCARE MAPS FOR HAMILTONIAN SYSTEM** **c67**
Claude Froeschle and Jean-Marc Petit *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 201-204 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Different methods are proposed and tested for transforming a non-linear differential system, and more particularly a Hamiltonian one, into a map without integrating the whole orbit as in the well-known Poincare return map technique. We construct piecewise polynomial maps by coarse-graining the phase-space surface of section into parallelograms and using either only values of the Poincare maps at the vertices or also the gradient information at the nearest neighbors to define a polynomial approximation within each cell. The numerical experiments are in good agreement with both the real symplectic and Poincare maps. Author

**N93-19161*#** Observatoire de la Cote d'Azur, Nice (France).
**THE EFFECT OF SECULAR RESONANCES IN THE ASTEROID REGION BETWEEN 2.1 AND 2.4 AU**
Christiane Froeschle and Hans Scholl *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 205-209 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The asteroid region between 2.1 and 2.4 AU appears to be depopulated at inclinations i greater than 12 deg. This region is surrounded by the three main secular resonances nu(sub 5), nu(sub 6), and nu(sub 16) and is crossed by higher order secular resonances. Secular resonances appear to overlap in this region. Numerical integrations of the orbits of seventeen fictituous asteroids with initial inclinations 12 deg less than or equal to i less than or equal to 20 deg show the following: (1) this particular asteroid region is not depopulated in our computer experiment on timescales of 2.7 Myrs; (2) inclinations are pumped up by successive crossings through higher order secular resonances while eccentricities are not increased sufficiently to produce planet-crossers; (3) bodies located in the bordering nu(sub 6) resonance with semi-major axes a less than or equal to 2.4 AU become Earth-crossers on a time scale of 1 Myr; and (4) we confirm the result that modes due to higher order secular resonances must be eliminated when proper elements are computed. Author

**N93-19162*#** Kent Univ., Canterbury (England). Unit for Space Sciences.
**A STRONG 3.4 MICRON EMISSION FEATURE IN COMET AUSTIN 1989c1**
S. F. Green, J. K. Davies (Royal Observatory, Edinburgh, Scotland ), T. R. Geballe (Joint Astronomy Centre, Hilo, HI.), T. Brooke (Hawaii Univ., Honolulu.), and A. T. Tokunaga (Hawaii Univ., Honolulu.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 211-214 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

High resolution 2.8-4.0 micron spectra of the 'new' comet Austin 1989c1, taken on 15-16 May 1990 confirm the presence of the broad emission features around 3.4 and 3.52 micron seen in a number of bright comets and ascribed to organic material. Both the 3.4 micron band strength and the 3.52/3.36 micron flux ratios are among the largest so far observed. The data are consistent with the relationship between band strength and water production rate that was recently derived. Excess emission at 3.28 and 3.6 micron cannot be unambiguously identified as features due to the poor signal-to-noise ratio. Author

**N93-19163*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**DEIMOS: A REDDISH, D-TYPE ASTEROID SPECTRUM**
William M. Grundy and Uwe Fink *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 215-218 (For primary document see N93-19113 06-90)
(Grants NAGw-1549; NGT-50661)
Avail: CASI HC A01/MF A04

We have obtained high quality CCD spectra of Deimos from 0.5 to 1.0 microns at a spectral resolution of 15 A. The spectra are remarkably red,

similar to the spectra of D type asteroids rather than those of carbonaceous chondrites or C type asteroids. During the 1988 opposition of Mars, we obtained new CCD spectra of its outer satellite, Deimos. The data were obtained over a 2 1/2 hour period on the night of 9 Oct., using the 1.54 meter Catalina telescope and the LPL long-slit CCD spectrometer. From 0.5 to 1.1 microns, the spectrum is dispersed across an 800 x 800 Texas Instruments CCD chip at a scale of 7.21 A per pixel for an effective lambda/delta(lambda) approximately equals 500. The primary observational difficulty in ground based spectroscopy of Deimos was its proximity to Mars. To minimize scattered light from Mars, Deimos was observed near greatest elongation. The spectrograph slit was narrowed to 2.5 arcseconds, slightly larger than the seeing disk. An apodizing mask at the re-imaged telescope primary, to remove the diffraction cross of Mars light caused by the telescope's secondary mirror mount. Residual scattered light was modeled and removed in data reduction. Solar analog stars BS560, BS2007, and BS8931 were observed to allow removal of telluric absorptions. The resulting spectrum is plotted with other data. Author

**N93-19164*#** Florida Univ., Gainesville. Dept. of Astronomy.
**DID EARTH-APPROACHING ASTEROIDS 3551, 3908, OR 4055 PRODUCE METEORITES?**
Bo A. S. Gustafson and I. P. Williams (Westfield Coll., London, England ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 219-222 Sponsored in part by Westfield Coll. (For primary document see N93-19113 06-90)
(Grant NAGw-1257)
Avail: CASI HC A01/MF A04

Orbital integrations show that Amor asteroid 3908 could have ejected one out of four plausible groups of meteorite producing fireballs during a collision in the asteroid belt. It was suggested by others that such a collision may also have split asteroids 3551 and 3908. A member of this group of fireballs is listed as one of the better possibilities for recovery. Author

**N93-19165*#** Florida Univ., Gainesville. Dept. of Astronomy.
**COLLISIONAL AND DYNAMIC EVOLUTION OF DUST FROM THE ASTEROID BELT**
Bo A. S. Gustafson, Eberhard Gruen (Max-Planck-Inst. fuer Kernphysik, Heidelberg, Germany ), Stanley F. Dermott, and Daniel D. Durda *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 223-226 Sponsored in part by Alexander von Humboldt Stiftung (For primary document see N93-19113 06-90)
(Grant NAGw-1257)
Avail: CASI HC A01/MF A04

The size and spatial distribution of collisional debris from main belt asteroids is modeled over a 10 million year period. The model dust and meteoroid particles spiral toward the Sun under the action of Poynting-Robertson drag and grind down as they collide with a static background of field particles. Author

**N93-19166*#** Manchester Univ. (England). Dept. of Astronomy.
**LONG-TERM EVOLUTION OF 1991 DA: A DYNAMICALLY EVOLVED EXTINCT HALLEY-TYPE COMET**
Gerhard Hahn and M. E. Bailey *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 227-230 Sponsored in part by Science Research Council (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The long-term dynamical evolution of 21 variational orbits for the intermediate-period asteroid 1991 DA was followed for up to +/-10(exp 5) years from the present. 1991 DA is close to the 2:7 resonance with Jupiter; it has avoided close encounters, within 1 AU, with this planet for at least the past 30,000 years, even at the node crossing. The future evolution typically shows no close encounters with Jupiter within at least 50,000 years. This corresponds to the mean time between node crossings with either Jupiter or Saturn. Close encounters with Saturn and Jupiter lead to a chaotic evolution for the whole ensemble, while secular perturbations cause large-amplitude swings in eccentricity and inclination (the latter covering the range 15 deg approximately less than i approximately less than 85 deg) which correlate with deep excursions of the perihelion distance to values much less than 1 AU. These variations are similar to those found in P/Machholz and a variety of other high-inclination orbits, e.g., P/Hartley-IRAS. We emphasize the connection between the orbital evolution of 1991 DA and that of Halley-type comets. If 1991 DA was once a comet, it is not surprising that it is now extinct. Author

**N93-19167*#** ASTEC, Inc., Tokyo (Japan).
**LIGHTCURVE OF COMET AUSTIN(1989c1) AND ITS DUST MANTLE DEVELOPMENT**
Hitoshi Hasegawa and Jun-Ichi Watanabe (Tokyo Astronomical Observatory, Mitaka, Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 231-234 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Brightness variations of comet Austin(1989c1) were investigated in terms of the variations of water production rate. We translated the visual brightness data into water production rates using Newburn's semi-empirical law. The curve of the water production rates as a function of heliocentric distance was compared with the model calculations that assumed energy balance between the solar incident and vaporization of water. Thermal flow in a dust mantle at a surface of the nucleus is also included in the model. The model calculations including the dust mantle are more favorable for the observed rate than non-dust mantle cases. The extinction after the perihelion passage suggests that the dust mantle developed gradually. Author

**N93-19168*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PALOMAR PLANET-CROSSING ASTEROID SURVEY (PCAS): RECENT DISCOVERY RATE**
Eleanor F. Helin *In* Lunar and Planetary Lab., Asteroids, Comets, Meteors 1991 1992 p 235-236 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The discovery rate of Near-Earth Asteroids (NEA's) has increased significantly in the last decade. As greater numbers of NEA's are discovered, worldwide interest has grown leading to new programs. With the introduction of CCD telescopes throughout the world, an increase of 1-2 orders of magnitude in the discovery rate can be anticipated. Nevertheless, it will take several decades of dedicated searching to accomplish a 95 percent completeness, even for large objects. Author

**N93-19169*#** Arizona State Univ., Tempe. **c89**
**SPECTROSCOPIC OBSERVATIONS OF COMET AUSTIN (1989c)**
Rodney Heyd, Susan Wyckoff, Peter Wehinger, and Peter Mack (Massachusetts Inst. of Tech., South Dartmouth.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 241-244 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Longslit CCD spectra (lambda = 5100-6400 A, delta(lambda) approximately 3 A) were obtained with the Michigan-Dartmouth-MIT 1.3 meter telescope in May 1990 (r = 0.74 AU, delta = 0.50 AU). The spectra were reduced with the Interactive data Reduction and Analysis Facility (IRAF). Spectral extractions offset sunward and tailward from the nucleus were analyzed. Species identified in the spectra include the following: C2, NH2(10-0), NH2(9-0), H2O(+), and CO(+). Spatial extractions of rotational line intensities in the NH2(10-0) band extend approximately 10(exp 4.5) km from the nucleus. A fit of the vectorial model to the NH2(10-0) spatial profile is consistent with an NH3 parent molecule. The NH2 production rate and an ammonia to water abundance ratio, NH3/H2O approximately 3 percent, were derived. The ammonia abundance obtained for comet Austin is consistent with that found for several other comets and is indicative of comet formation under very homogeneous conditions. Author

**N93-19170*#** Academy of Sciences (USSR), Dushanbe. Inst. of Astrophysics.
**METALLIC ATOMS AND IONS IN COMETS: COMET HALLEY 1986 3**
S. Ibadov *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 241-244 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The origin of metallic atoms and ions in the cometary comae is investigated theoretically. Two effects are revealed in the comas of bright comets: (1) the Na anomalous type effect is possible within the gas-dust jets of comet P/Halley 1986 3 due to cooling cometary dust by cryogenic gas flow from the nucleus; and (2) the production of ions of refractory elements (Fe(+), Si(+), etc.) at large heliocentric distances is possible in the comas of the Halley type dusty comets due to high-velocity impacts

between cometary and zodiacal dust particles. Spectral observations of comets with high sensitivity and spatial resolution are important for studying both comets and interplanetary dust. Author

**N93-19171*#** Academy of Sciences (USSR), Moscow. Inst. of Applied Mathematics.

**ASTEROID-TYPE ORBIT EVOLUTION NEAR THE 5:2 RESONANCE**

S. I. Ipatov *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 245-248 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

In this case of the 5:2 commensurability with the motion of Jupiter, an asteroid can reach the orbits of Mars, Earth, and Venus when eccentricity e is greater than 0.41, 0.65, and 0.74, respectively. For individual fictitious asteroids, Ipatov and Yoshikawa obtained a growth in e from 0.15 to 074-0.76. Rates of changes in orbital orientations are different for Mars, Earth, Venus, and the asteroid. Therefore, for corresponding values of e, the asteroid could encounter these planets and leave the gap at those encounters. In order to investigate this hypothesis of the 5:2 Kirkwood gap formation, Ipatov studied the regions of initial data for which the eccentricities of asteroids located near the 5:2 commensurability exceeded 0.41 during evolution. The orbit evolution for 500 fictitious asteroids was investigated by numerical integration of the complete (unaveraged) equations of motion for the three-body problem (Sun-Jupiter-asteroid). The equations of motion were integrated in the time intervals T is greater than or equal to 5(10)(exp 3)t(sub J) (t(sub J) is the heliocentric orbital period of Jupiter) in the planar model, T is greater than or equal to 10(exp 4)t(sub J) at initial inclination 5 deg is less than or equal to i(sub 0) is less than or equal to 20 deg and T = 10(exp 5)t(sub J) at i(sub 0) = 40 deg. The larger interval T was taken at i(sub 0) = 40 deg because in this case for the majority of runs maximum values of e and i were reached in the time delta(t) is greater than 2(10)(exp 4)t(sub J). Author

**N93-19172*#** California Univ., Davis. Dept. of Chemistry.

**FORMATION OF IONS AND RADICALS FROM ICY GRAINS IN COMETS**

William M. Jackson *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 249-252 (For primary document see N93-19113 06-90)
(Grant NAGw-1144)
Avail: CASI HC A01/MF A04

Two theoretical models for the formation of radicals from ice grains are examined to determine if this can explain the jets in comets. It is shown that the production rates for these radicals by the photolysis of molecules in the icy grains are not high enough to explain the jets. A new mechanism is proposed involving the release of cations and anions in the gas phase as the icy mantle surrounding the grains is evaporated. Solar visible radiation can then form radicals by photodetachment of the electrons from these anions. The production rate of radicals formed in this manner is in accord with the production rates of the observed radicals. Author

**N93-19173*#** California Univ., Davis. Dept. of Chemistry.

**COMETARY IMPLICATIONS OF RECENT LABORATORY EXPERIMENTS ON THE PHOTOCHEMISTRY OF THE C2H AND C3H2 RADICALS**

William M. Jackson, Yihan Bao, Randall S. Urdahl, Xueyu Song, Jai Gosine, and Chi Lu *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 253-256 (For primary document see N93-19113 06-90)
(Grant NAGw-903)
Avail: CASI HC A01/MF A04

Recent laboratory results on the photodissociation of the C2H and C3H2 radicals are described. These studies show that the C2 and C3 radicals are produced by the 193 nm photolysis of the C2H and C3H2 radicals, respectively. The quantum state distributions that were determined for the C2 radicals put certain constraints on the initial conditions for any models of the observed C2 cometary spectra. Experimental observations of C2 formed by the 212.8 nm photolysis of C2H are used to calculate a range of photochemical lifetimes for the C2H radical. Author

**N93-19174*#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).

**H2O(+) STRUCTURES IN THE INNER PLASMA TAIL OF COMET AUSTIN**

Klaus Jockers, T. Bonev (Bulgarian Academy of Sciences, Sofia.), and E. H. Geyer (Observatorium Hoher List, Daun, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 257-260 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We present images of comet Austin 1989c1 in the light of H2O(+) from which the contribution of the dust continuum and the gas coma was completely removed. We describe the behavior of the H2O(+) plasma in the inner coma where it is reliably observed for the first time. Author

**N93-19175*#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).

**FIRST IMAGES OF A POSSIBLE CO(+)-TAIL OF COMET P/SCHWASSMANN-WACHMANN 1 OBSERVED AGAINST THE DUST COMA BACKGROUND**

Klaus Jockers, T. Bonev (Bulgarian Academy of Sciences, Sofia.), Violeta Ivanova (Bulgarian Academy of Sciences, Sofia.), and H. Rauer *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 261-264 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Comet P/Schwassmann-Wachmann 1 was observed with the 2m-Ritchey-Cretien Telescope of the Bulgarian National Observatory, Rozhen, Bulgaria, using the CCD-camera and focal reducer of the Max-Planck-Institute for Aeronomy. Images were taken in a red continuum window and in the 2-0 A(exp 2)Pi - X(exp 2)Sigma(+) band of CO(+) located in the blue part of the spectrum. The red images reveal an extended dust coma. From a comparison of the red and blue images a dust reddening of 13.2 percent per 1000 A is derived. At 642 nm the magnitude of the comet with a square diaphragm of 4.5 arcsec is 16.6. The blue images, taken in the CO(+) band, show a significantly different brightness distribution which is interpreted as presence of a CO(+) coma and tail superimposed on the continuum. A column density of several 10(exp 10) CO(+) molecules cm(exp -2) is derived. The tail thickness of 10(exp 5) km is unexpectedly small. We estimate the CO(+) production rate to about 6 x 10(exp 26) CO(+) particles s(exp -1). This value does not support the idea that the outbursts of this comet are caused by crystallization of amorphous water ice. Author

**N93-19176*#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).

**DOPPLER VELOCITIES IN THE ION TAIL OF COMET LEVY 1990c**

Klaus Jockers, H. Rauer, C. Debi-Prasad, and E. H. Geyer (Observatorium Hoher List, Daun, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 265-268 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We have obtained time alternating sequences of column density maps and Doppler velocity fields in the plasma tail of comet Levy 1990c. We describe the observing technique and data analysis, and we present first results. Author

**N93-19177*#** University of Western Ontario, London. Dept. of Physics.

**EVOLUTION OF THE QUADRANTID METEOR STREAM**

James Jones and William Jones (Sheffield Univ., England ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 269-272 Sponsored by Natural Sciences and Engineering Council (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

According to previous orbital calculations, the last close approach of the Quadrantid stream with Jupiter occurred 3200 years ago at which time the parent comet of the stream may have been captured into its present short-period orbit. If this is the case the stream may only be a few thousand years old. We have modeled the evolution of the stream to determine if such a short time scale is consistent with the observed features of the Quadrantid/ delta- Aquarid/Arietid/Ursid complex. A detailed modeling of a stream consisting of 500 test particles released 4000 yr ago and which included the effects of the gravitational perturbations of 6 planets as well as the likely spread in the initial orbital elements resulting from the ejection of the grains from the comet was carried out. Our calculations indicate that an intense shower should be seen a few days before the Quadrantid shower, and that, 4000 yr is too short a period for the branch corresponding to the D-Arietid branch to appear. We have considered the

quasi-constants of motion 1/a and J, the Tisserand quantity, and find that the Ursids and the D-Arietids are unlikely to be members of the complex, and that, the complex is probably be less than 4000 yr old. Author

**N93-19178*#** University of Western Ontario, London. Dept. of Physics.
**FORWARD-SCATTER RADIANT MAPPING** **c89**
James Jones and A. R. Webster *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 273-276 Sponsored by Supply and Services Canada (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Forward-scatter systems have been much neglected for the study of meteors and meteor streams. A great deal of this neglect stems from the complicated geometry which has made the interpretation of results difficult in the past. This no longer presents a problem because of the computer power now available. There are practical advantages in using forward-scatter in that low-power transmitters are much easier to handle than the high-power ones used in pulsed back-scatter radars. The data reduction of the CW signals is also significantly simpler. Because the forward-scatter reflection geometry increases the duration of the echoes relative to the back-scatter case, the problem of the underdense ceiling is partially alleviated. We have built a 'short hop' forward-scatter system between Ottawa and London (Ont) for which the transmitter and receiver are separated by about 500 km. With it, we are able to measure unambiguously the directions of arrival of the echoes using a 5-antenna interferometer. Morton and Jones (1982, MN, 198, 737) have shown how the echo direction distribution can be deconvolved to yield the meteor radiant distribution for back-scatter data. We have extended the technique to the forward-scatter case and present some preliminary meteor radiant distribution maps. Author

**N93-19179*#** Sheffield Univ. (England). Dept. of Physics.
**EFFECT OF THE GEOMAGNETIC FIELD ON THE DIFFUSION OF METEOR TRAINS**
William Jones and James Jones (University of Western Ontario, London.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 277-280 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A solution to the problem of the diffusion of a meteor train in the geomagnetic field from an initial line density may be written in closed form in terms of effective diffusion coefficients depending on direction, enabling detailed calculations across the entire range of angle of train to field and relevant heights. While the effective diffusion coefficient in the plane of train and field then remains close to the zero field ambipolar value right up to 90 deg, the effective coefficient in the direction of the normal to plane of train and field drops steadily to its theta = 0 value at theta = 90 deg. At 95 km this corresponds to a change of almost 5 km, in 'diffusion height', that is, the height of an underdense meteor calculated on the basis of the exponential decay of its radar echo. We have estimated the consequent changes in the expected distribution of diffusion heights for various orientations of radar antenna and find the dependence on azimuth is very marked. The effect of the field is relatively minor for a south pointing beam but very strong if the beam is pointing north. Author

**N93-19180*#** Sheffield Univ. (England). Dept. of Physics.
**OBSERVATION OF METEORS BY MST RADAR** **c89**
William Jones and S. P. Kingsley *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 281-284 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The observation of meteor trails by a vertical mesosphere - stratosphere - troposphere (MST) radar beam has the advantage of good height resolution and an approximate knowledge of the zenith angle since the trails are horizontal or near-horizontal. An extension of the ablation theory of meteors was developed for near horizontal trails which takes into account the curvature of the earth. Observations of the Geminid meteor shower by MST radar reveal the 'diffusion heights' to be in fair agreement with the true height, but with some discrepancies that can amount to 4 km. The true heights are almost entirely confined to the range 87-91 km, although the upper limit is attributed to the coherent integration time of the existing MST radar processing. Author

**N93-19181*#** Observatoire de Paris-Meudon (France).
**THE CORRELATION BETWEEN WATER PRODUCTION RATES AND VISUAL MAGNITUDES IN COMETS**
L. Jorda (European Southern Observatory, La Silla, Chile ), Jacques Crovisier, and D. W. E. Green (Smithsonian Astrophysical Observatory, Cambridge, MA.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 285-288 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

From the visual magnitudes of the International Comet Quarterly data base and the OH radio lines measured at the Nancay radio telescope, the law log Q(H2O) = 30.74 (+/-0.02) - 0.240 (+/-.003) m(sub h) is derived from a sample of 13 comets. Author

**N93-19182*#** Helsinki Univ. (Finland). Observatory and Astrophysics Lab.
**INVERSION METHODS FOR INTERPRETATION OF ASTEROID LIGHTCURVES** **c89**
Mikko Kaasalainen, L. Lamberg, and K. Lumme *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 289-292 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We have developed methods of inversion that can be used in the determination of the three-dimensional shape or the albedo distribution of the surface of a body from disk-integrated photometry, assuming the shape to be strictly convex. In addition to the theory of inversion methods, we have studied the practical aspects of the inversion problem and applied our methods to lightcurve data of 39 Laetitia and 16 Psyche. Author

**N93-19183*#** Forschungszentrum Juelich G.m.b.H. (Germany). Inst. fuer Nuklearchemie.
**MODIFICATION OF PRIMORDIAL ICES BY COSMIC RAYS AS SIMULATED BY CYCLOTRON IRRADIATION**
R. I. Kaiser and K. Roessler *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 293-296 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Frozen CH4 and CH4/Ar mixtures closed into metal cuvettes and open to the vacuum were irradiated at 15 and 77 K with 10 - 20 MeV p and He-3(2+) ions in order to simulate the effect of cosmic rays on solid organic matter in space. Ices exposed to vacuum represent surfaces of icy systems whereas closed systems stand for bulk ices. The products were analyzed by MS, SEM, RBS, ERDA, H-1-NMR, HPLC, GC-MS, NEXAFS, and FT-IR. Volatile products consisted of a mixture of low molecular species, e.g., C2H2, C2H4, C2H6, and long linear aliphatic and olefinic compounds. The formation of polycyclic aromatic hydrocarbons (PAH's) and related species in solid CH4 is due to a multi-center reaction within one collision cascade and is governed by energy density effects with critical linear energy transfer values L(sub T) between 2 and 10 keV/micron. Open ices exhibit preferential hydrogen release resulting in an increased carbonization as compared to more hydrogen rich molecules protected inside large icy bodies. Author

**N93-19184*#** Newcastle Univ. (England). Dept. of Physics.
**METEOR FIREBALL SOUNDS IDENTIFIED**
Colin Keay *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 297-300 Sponsored in part by Science Research Council (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Sounds heard simultaneously with the flight of large meteor fireballs are electrical in origin. Confirmation that Extra/Very Low Frequency (ELF/VLF) electromagnetic radiation is produced by the fireball was obtained by Japanese researchers. Although the generation mechanism is not fully understood, studies of the Meteorite Observation and Recovery Project (MORP) and other fireball data indicate that interaction with the atmosphere is definitely responsible and the cut-off magnitude of -9 found for sustained electrophonic sounds is supported by theory. Brief bursts of ELF/VLF radiation may accompany flares or explosions of smaller fireballs, producing transient sounds near favorably placed observers. Laboratory studies show that mundane physical objects can respond to electrical excitation and produce audible sounds. Reports of electrophonic sounds should no longer be discarded. A catalog of over 300 reports relating to electrophonic phenomena associated with meteor fireballs, aurorae, and lightning was

assembled. Many other reports have been cataloged in Russian. These may assist the full solution of the similar long-standing and contentious mystery of audible auroral displays. Author

**N93-19185*#** Comenius Univ., Bratislava (Czechoslovakia). Dept. of Astronomy and Astrophysics.
**ON THE ASTEROIDAL JET-STREAM FLORA A**
Jozef Klacka *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 301-304 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The problems of the virtual existence of the Flora 1, separated from the rest of the Flora family, and jet-stream Flora A (Alfven 1969) is discussed in connection with the observational selection effects. It is shown that observational selection effects operate as a whole and can be important in incomplete observational data set. Author

**N93-19186*#** Astronomical Observatory, Belgrade (Yugoslavia).
**ASTEROID PROPER ELEMENTS AND SECULAR RESONANCES**
**Progress Report**
Zoran Knezevic (Pisa Univ., Italy ) and Andrea Milani (Pisa Univ., Italy ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 305-308 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

In a series of papers (e.g., Knezevic, 1991; Milani and Knezevic, 1990; 1991) we reported on the progress we were making in computing asteroid proper elements, both as regards their accuracy and long-term stability. Additionally, we reported on the efficiency and 'intelligence' of our software. At the same time, we studied the associated problems of resonance effects, and we introduced the new class of 'nonlinear' secular resonances; we determined the locations of these secular resonances in proper-element phase space and analyzed their impact on the asteroid family classification. Here we would like to summarize the current status of our work and possible further developments. Author

**N93-19187*#** Academy of Sciences (USSR), Leningrad. Inst. of Theoretical Astronomy.
**INTEGRATED SOFTWARE PACKAGE STAMP FOR MINOR PLANETS** **c61**
O. M. Kochetova and Viktor A. Shor *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 309-311 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The integrated software package STAMP allowed for rapid and exact reproduction of the tables of the year-book 'Ephemerides of Minor Planets.' Additionally, STAMP solved the typical problems connected with the use of the year-book. STAMP is described. The year-book 'Ephemerides of Minor Planets' (EMP) is a publication used in many astronomical institutions around the world. It contains all the necessary information on the orbits of the numbered minor planets. Also, the astronomical coordinates are provided for each planet during its suitable observation period. Author

**N93-19188*#** Cologne Univ. (Germany). Dept. of Nuclear Chemistry.
**PARTICLE EMISSION FROM ARTIFICIAL COMETARY MATERIALS**
Gabriele Koelzer, Hermann Kochan (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, Germany ), and Klaus Thiel *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 313-316 (For primary document see N93-19113 06-90)
(Contracts DFG-KO-973/1-3; DFG-TH-320/5-1)
Avail: CASI HC A01/MF A04

During KOSI (comet simulation) experiments, mineral-ice mixtures are observed in simulated space conditions. Emission of ice-/dust particles from the sample surface is observed by means of different devices. The particle trajectories are recorded with a video system. In the following analysis we extracted the parameters: particle count rate, spatial distribution of starting points on the sample surface, and elevation angle and particle velocity at distances up to 5 cm from the sample surface. Different kinds of detectors are mounted on a frame in front of the sample to register the emitted particles and to collect their dust residues. By means of these instruments the particle count rates, the particle sizes and the composition of the particles can be correlated. The results are related to the gas flux density and the temperature on the sample surface during the insolation period. The particle emission is interpreted in terms of phenomena on the sample surface, e.g., formation of a dust mantle. Author

**N93-19189*#** Academy of Sciences, Graz (Austria). Space Research Inst.
**THE EFFECT OF A NON-VOLATILE DUST MANTLE ON THE ENERGY BALANCE OF COMETARY SURFACE LAYERS**
Norbert I. Koemle and Gerhard Steiner *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 317-320 (For primary document see N93-19113 06-90)
(Grant FFWF-P-7246-GEO)
Avail: CASI HC A01/MF A04

It is likely that large parts of a cometary surface layer consist of porous ices, which are covered by a thin layer of non-volatile debris, whose structure is also fluffy and porous. In this paper the results of model calculations are presented. The calculations show the effect of ice and dust pore sizes and of the dust mantle thickness upon the thermal behavior of such a dust-ice system, when it is irradiated by the sun. In particular, it is found that the average pore size of the ice and the dust material has a large influence both on the dust surface temperature and on the temperature at the dust-ice interface. Author

**N93-19190*#** Southwest Research Inst., San Antonio, TX.
**DISTURBANCES OF BOTH COMETARY AND EARTH'S MAGNETOSPHERES EXCITED BY SINGLE SOLAR FLARES** **c92**
I. Konno, T. Saito (Tohoku Univ., Sendai, Japan ), Y. Kozuka (Tohoku Univ., Sendai, Japan ), K. Nishioka (Olympus Optical Co. Ltd., Tokyo, Japan ), M. Saito (Saito Astronomical Observatory, Japan ), and T. Takahashi (Tohoku Univ., Sendai, Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 321-324 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

In the solar wind a comet plays the role of a windvane that moves three-dimensionally in the heliomagnetosphere. Among the solar systems bodies, only comets have a wide range of inclination angles of their orbital planes to the ecliptic plane ranging from 0 to 90 deg. Therefore, observations of cometary plasma tails are useful in probing the heliomagnetospheric conditions in the high heliolatitudinal region. A comet can be compared to a polar-orbiting probe encircling the Sun. We will introduce two rare cases in which the magnetospheres of both the comet and the Earth are disturbed by a single solar flare. Author

**N93-19191*#** Leiden Univ. (Netherlands). Lab. Astrophysics.
**A NEW MEASUREMENT OF THERMAL CONDUCTIVITY OF AMORPHOUS ICE AND ITS IMPLICATIONS FOR THE THERMAL EVOLUTION OF COMETS**
Akira Kouchi, J. M. Greenberg, T. Yamamoto (Tokyo Univ., Sagamihara, Japan ), T. Mukai (Kobe Univ., Japan ), and Z. F. Xing *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 325-328 Sponsored in part by Netherlands Organization for Applied Scientific Research; Japan Society for the Promotion of Science; Tsukuba Univ.; and Yamada Science Foundation (For primary document see N93-19113 06-90)
(Grant NGR-33-018-148)
Avail: CASI HC A01/MF A04

Very slowly deposited amorphous ice has a thermal conductivity about four orders of magnitude or more smaller than hitherto estimated. Using the exceedingly low value of the thermal conductivity of comets deduced from the properties of amorphous ice leads to the expectation that internal heating of comets is negligible below the outer several tens of centimeters. Author

**N93-19192*#** Tohoku Univ., Sendai (Japan). Geophysical Inst.
**THE SOLAR WIND STRUCTURE THAT CAUSED A LARGE-SCALE DISTURBANCE OF THE PLASMA TAIL OF COMET AUSTIN** **c92**
Yukio Kozuka, Ichishiro Konno (Southwest Research Inst., San Antonio, TX.), Takao Saito, and Shigemi Numazawa (Japan Planetarium Lab.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 329-332 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The plasma tail of Comet Austin (1989c1) showed remarkable disturbances because of the solar maximum periods and its orbit. Figure 1

shows photographs of Comet Austin taken in Shibata, Japan, on 29 Apr. 1990 UT, during about 20 minutes with the exposure times of 90 to 120 s. There are two main features in the disturbance; one is many bowed structures, which seem to move tailwards; and the other is a large-scale wavy structure. The bowed structures can be interpreted as arcade structures brushing the surface of both sides of the cometary plasma surrounding the nucleus. We identified thirteen structures of the arcades from each of the five photographs and calculated the relation between the distance of each structure from the cometary nucleus, chi, and the velocity, upsilon. The result is shown. This indicates that the velocity of the structures increases with distance. This is consistent with the result obtained from the observation at the Kiso Observatory. Author

**N93-19193*#** Adam Mickiewicz Univ., Poznan (Poland). Astronomical Observatory.

**SPIN VECTOR AND SHAPE OF 532 HERCULINA**

T. Kwiatkowski and Tadeusz Michalowski *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 333-336 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Herculina has been observed during 7 oppositions: 1954 (Groeneveld and Kuiper), 1963 (Chang and Chang), 1978 (Harris and Young), 1982 (Drummond et al.; Weidenschilling et al.), 1984 (Taylor et al.), 1985 (Erikson et al.), and 1987 (Lebofsky et al.; Weidenschilling et al.). This asteroid has very unusual lightcurves. They exhibit two maxima and minima in 1978, 1984, and 1987, and only one maximum and minimum in 1954, 1963, and 1982 per rotation cycle of about 9.4 hours. The 1985 lightcurve, which is very close in aspect to those from 1963, shows two maxima and minima. The primary minimum is very similar to a single minimum in 1963, while the secondary one is only 0.06 mag deep. In 1963 no secondary minimum was visible. Author

**N93-19194*#** Arizona Univ., Tucson. Lunar and Planetary Lab.

**EVALUATING SOME COMPUTER EXHANCEMENT ALGORITHMS THAT IMPROVE THE VISIBILITY OF COMETARY MORPHOLOGY c61**

Stephen M. Larson and Charles D. Slaughter (Photometrics, Inc., Tucson, AZ.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 337-343 (For primary document see N93-19113 06-90)

(Grant NAGw-1974)

Avail: CASI HC A02/MF A04

Digital enhancement of cometary images is a necessary tool in studying cometary morphology. Many image processing algorithms, some developed specifically for comets, have been used to enhance the subtle, low contrast coma and tail features. We compare some of the most commonly used algorithms on two different images to evaluate their strong and weak points, and conclude that there currently exists no single 'ideal' algorithm, although the radial gradient spatial filter gives the best overall result. This comparison should aid users in selecting the best algorithm to enhance particular features of interest. Author

**N93-19195*#** Osservatorio Astronomico, Padova (Italy). Dipt. di Astronomia.

**HELIOCENTRIC DISTANCE DEPENDENCIES OF THE C2 LIFETIME AND C2 PARENT PRODUCTION RATE IN COMET P/BRORSEN-METCALF (1989o)**

M. Lazzarin, Giau Paolo Tozzi (Osservatorio Astrofisico di Arcetri, Florence, Italy ), C. Barbieri, and Michel C. Festou (Observatoire de Midi-Pyresnees, Toulouse, France ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 345-348 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Comet P/Brorsen-Metcalf (1989o) has been extensively observed in the visible and in the ultraviolet during its latest apparition of summer 1989. In this paper we report a preliminary determination of the C2 production rates and lifetimes and we compare those rates to the H2O production rates obtained from UV data. Author

**N93-19196*#** Paris VI Univ. (France). Service d'Aeronomie.

**POLARIMETRIC OBSERVATIONS OF COMET LEVY 1990c AND OF OTHER COMETS: SOME CLUES TO THE EVOLUTION OF COMETARY DUST**

Anny-Chantal Levasseur-Regourd, J. B. Renard, and E. Hadamcik *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 349-352 Sponsored in part by Programme National de Planetologie (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

The evolution with the phase angle alpha of the polarization degree P of light scattered by comet Halley's dust is well documented. No significant discrepancy is found between Halley and Levy polarization curves near the inversion point. From all available cometary observations, we have derived polarimetric synthetic curves. Typically, a set of about 200 data points in the red wavelengths range exhibits a minimum for (alpha approximately equals 10.3 degrees, P approximately equals 1.8 percent) and an inversion point for (alpha approximately equals 22.4 degrees, P = 0 percent), with a slop of about 0.27 percent per degree. A significant spreading of some data (comets Austin 1982VI, Austin 1989c1, West 1976VI) is found at large phase angles. The analysis of our polarimetric maps of Levy reveals that the inner coma is heterogeneous. The increase of the inversion angle value with increasing distance from the photometric center is suspected to be due to the evolution with time of grains ejected from the nucleus. A fan like structure could be produced by a jet of grains freshly ejected. Author

**N93-19197*#** Naval Observatory, Washington, DC. Orbital Mechanics Dept.

**THE STATE OF KNOWLEDGE CONCERNING THE KUIPER BELT**

Harold F. Levison *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 353-357 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

The arguments for and against the idea that most short-period comets originate in the Kuiper belt are discussed. Observational constraints on the distribution of mass in the Kuiper belt are reviewed as well as a model of the physical conditions that now exist. Finally, predictions from this model about the detectability of the Kuiper belt are compared to optical surveys. Author

**N93-19198*#** Bucknell Univ., Lewisburg, PA.

**NUMERICAL SIMULATIONS OF COMETARY DUST**

David J. Lien *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 359-362 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Most observations of comets are done photometrically or spectrophotometrically. The interpretation of the aperture-averaged flux is relatively simple for an isotropic, radially expanding coma of infinite extent - the canonical model. However, the interpretation of the observations is not so clear when the motion of the dust is affected by radiation pressure, or when the emission is time-varying and anisotropic. For example, in a sample of CCD images of 10 comets, Jewitt and Meech (1987, Ap.J. 317, 992) found that the photometric profiles of only three comets were consistent, within the observational errors, with the profiles predicted form the canonical model. Photometric observations with large apertures, however, seem to suggest that the canonical model may be quite adequate (c.f. Osip, Schleicher, and Millis, 1992, Icarus 98, 115). The dust itself is characterized by a size distribution, with size dependencies on the expansion velocity, the scattered and thermal radiation, the response to radiation pressure, and probably the density. How good then are the approximations normally used in determining the production rates of the dust when these effects are present? As part of a program to better understand the dynamics of cometary dust and gas, a computer program has been developed which numerically simulates the emission of both dust and gas from a tilted rotating nucleus. Author

**N93-19199*#** Lund Observatory (Sweden).

**A COMPUTER SEARCH FOR ASTEROID FAMILIES**

Bertil A. Lindblad *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 363-366 (For primary document see N93-19113 06-90)

(Grant SNSRC-2043-1)

Avail: CASI HC A01/MF A04

The improved proper elements of 4100 numbered asteroids have been searched for clusterings in a, e, i space using a computer technique based on the D-criterion. A list of 14 dynamical families each with more

than 15 members is presented. Quantitative measurements of the density and dimensions in phase space of each family are presented. Author

**N93-19200*#** Lund Observatory (Sweden).
**ACTIVITY OF THE LYRID METEOR STREAM**
Bertil A. Lindblad and V. Porubcan (Slovak Academy of Sciences, Bratislava, Czechoslovakia ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 367-370 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The activity of the Lyrid meteor stream is in most years fairly low with a visual rate at maximum (21-22 April) of 5-10 meteors per hour. Short bursts of very high Lyrid activity, with visual hourly rates of 100 or more, have sometimes been reported. These observations generally refer to faint visual meteors. The reported bursts of high activity have occurred in a very narrow interval of solar longitudes (deg 31.24 to 31.38 equinox 1950.0), while the recurrent or 'normal' maximum for bright meteors occurs at solar longitude deg 31.6, or slightly later. A mass separation of the meteors in the shower is thus indicated. Author

**N93-19201*#** Astronomical Observatory, Uppsala (Sweden).
**DYNAMICAL TIMESCALES IN THE JUPITER FAMILY**
Mats Lindgren *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 371-374 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Numerically integrated fictitious comets starting in orbits perihelion tangent to Jupiter have been used to estimate the duration of a typical visit to the observable Jupiter family of comets. The results show values of 3 to 6 thousand years, narrowing the previously estimated interval of 10(exp 3) to 10(exp 4) years. Author

**N93-19202*#** Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
**ACTIVITY IN DISTANT COMETS**
Jane X. Luu *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 375-378 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Activity in distant comets remains a mystery in the sense that we still have no complete theory to explain the various types of activity exhibited by different comets at large distances. This paper explores the factors that should play a role in determining activity in a distant comet, especially in the cases of comet P/Tempel 2, comet Schwassmann-Wachmann 1, and 2060 Chiron. Author

**N93-19203*#** Westfield Coll., London (England).
**PHILOSOPHY AND UPDATING OF THE ASTEROID PHOTOMETRIC CATALOGUE** **c82**
Per Magnusson, M. Antonietta Barucci (Observatoire de Paris-Meudon, France ), M. T. Capria (Viale Univ., Rome, Italy ), Mats Dahlgren (Astronomical Observatory, Uppsala, Sweden ), Marcello Fulchignoni (La Sapienza Univ., Rome, Italy ), and C. I. Lagerkvist (Astronomical Observatory, Uppsala, Sweden ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 379-380 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The Asteroid Photometric Catalogue now contains photometric lightcurves for 584 asteroids. We discuss some of the guiding principles behind it. This concerns both observers who offer input to it and users of the product. Author

**N93-19204*#** Osservatorio Astronomico, Brera, Milan (Italy).
**COMETARY ORBITAL EVOLUTION IN THE OUTER PLANETARY REGION**
Allesandro Manara and G. B. Valsecchi (Viale Univ., Rome, Italy ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 381-384 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Numerical integrations of fictitious objects are carried out in order to elucidate the dynamical behavior of potential short-period comets when they move in orbits at distances from the Sun comparable to those of Uranus and Neptune. As in the case of observed short-period comets, close encounters with the planets play a major role for the orbital evolution, and this is especially true for encounters with initial orbits nearly tangent to that of the planet. A comparison with integrations in which the planetary masses are larger by a factor 10 shows that, in the latter case, the orbital evolution is greatly accelerated, but the dynamical paths in phase space followed by the comets are altered. Author

**N93-19205*#** Red Deer Coll. (Alberta).
**THE ELEVEN OBSERVATIONS OF COMETS BETWEEN 687 AD AND 1114 AD RECORDED IN THE ANGLO SAXON CHRONICLE** **c89**
E. G. Mardon, J. Williams, and A. A. Mardon *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 385-393 Prepared in cooperation with Texas A&M Univ., College Station (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

This research paper is an examination of the eleven cometary references (679AD, 729AD, 892AD, 950AD, 975AD, 995AD, 1066AD, 1097AD, 1106AD, 1110AD and 1114AD) found in the various manuscripts of The Anglo Saxon Chronicle between 678 AD and 1114 AD. The manuscripts contain more than 35 celestial observations. This is an examination of astronomical phenomena and other climatic or natural events, that are described in The Anglo Saxon Chronicle, which is also referred to as The Old English Annals. Author

**N93-19206*#** Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
**THE RECOVERY OF ASTEROIDS AFTER TWO OBSERVATIONS** **c89**
Brian G. Marsden *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 395-398 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

It is shown that a generalization of the use of 'Vaisala orbits', briefly mentioned at the Asteroids 2 Conference, can be very conveniently accomplished by means of an inversion of the 'GEM' form of the Gauss method. The procedure can also be applied to Apollo objects and to indeterminate cases of normal three-observation orbit computation, and there is also a simple extension to situations involving four or more observations. Author

**N93-19207*#** University of Southwestern Louisiana, Lafayette. Dept. of Physics.
**COMET NONGRAVITATIONAL FORCES AND METEORITIC IMPACTS**
John J. Matese, Patrick G. Whitman, and Daniel P. Whitmire *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 399-402 Sponsored by NASA. Ames Research Center (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

We have considered those comets whose original orbits have been determined to be hyperbolic when only planetary perturbations are accounted for. It is found that formally unbound incident trajectories correlate most confidently with orbits that have small perihelion distances and move in a retrograde sense relative to planetary motion. Arguments are presented that these results are not due to measurement error or to selection effects. We conclude that the phenomenon is attributable to enhanced volatility leading to abnormally large nongravitational forces. Since the effect is absent in the prograde small-perihelia population, increased insolation is not the sole explanation. It is suggested that the significance of the retrograde correlation is connected with a larger energy of relative motion between retrograde comets and a population of prograde ecliptic meteoroids which impact the comet mantle exposing the underlying volatiles. The subsequent enhanced outgassing is the cause of the larger nongravitational forces. Author

**N93-19208*#** Sheffield Univ. (England). Dept. of Physics.
**THE SPATIAL DISTRIBUTION OF LARGE COMETARY METEOROIDS IN THE INNER SOLAR SYSTEM**
Neil McBride and David W. Hughes *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 403-406 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A model of the spatial density distribution of large (m greater than 10(exp -3) g) cometary meteoroids in the inner solar system is obtained

assuming that they have orbits closely associated with that of their parent comet. Distributions of the orbital parameters of the Taurid, Quadrantid and Perseid meteoroid streams are used in developing the model. Author

**N93-19209*#** Kent Univ., Canterbury (England). Unit for Space Sciences.

**THE GEOCENTRIC PARTICULATE DISTRIBUTION: COMETARY, ASTEROIDAL, OR SPACE DEBRIS?**

J. A. M. McDonnell and P. R. Ratcliff *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 407-411 (For primary document see N93-19113 06-90)

(Grant SERC-GR/F/80463)

Avail: CASI HC A01/MF A04

Definition of the Low Earth Orbit (LEO) particulate environment has been refined considerably with the analysis of data from NASA's Long Duration Exposure Facility (LDEF). Measurements of the impact rates from particulates ranging from sub-micron to millimetres in dimension and, especially, information on their directionality has permitted new scrunity of the sources of the particulates. Modelling of the dynamics of both bound (Earth orbital) and unbound (hyperbolic interplanetary) particulates intercepting LDEF's faces leads to the conclusion that the source is dominantly interplanetary for particle dimensions of greater than some 5 microns diameter; however the anisotropy below this dimension demands lower velocities and is compatible with an orbital component. Characteristics of the LDEF interplanetary component are compatible with familiar meteoroid sources and deep space measurements. Understanding of the orbital component which exceeds the interplanetary flux by a factor of 4 is less clear; although the very small particulates in orbit have been associated with space debris (Lawrance and Brownlee, 1986) this data conflicts with other measurements (McDonnell, Carey and Dixon, 1984) at the same epoch. By analysis of trajectories approaching the Earth and its atmosphere, we have shown that a significant contribution could be captured by aerocapture, i.e., atmospheric drag, from either asteroidal or cometary sources; such enhancement is unlikely however to provide the temporal and spatial fluctuations observed by the LDEF Interplanetary Dust Experiment (Mullholland et al. 1992). A further new mechanism is also examined, that of aerofragmentation capture, where an atmospheric grazing trajectory, which would not normally lead to capture, leads to fragmentation by thermal or mechanical shock; the microparticulates thus created can be injected in large numbers, but only into short-lifetime orbits. The concentration in one particular orbit plane, could explain the temporal fluctuations seen on LDEF; space debris could also explain the phenomenon. Author

**N93-19210*#** California Univ., San Diego, La Jolla. Space Inst.

**NEAR INFRARED REFLECTANCE SPECTRA: APPLICATIONS TO PROBLEMS IN ASTEROID-METEORITE RELATIONSHIPS** **c89**

Lucy A. McFadden and Alan B. Chamberlin *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 413-416 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

An observing program designed to search for evidence of ordinary chondrite parent bodies near the 3:1 Kirkwood Gap was carried out in 1985 and 1986. Studies by Wisdom (1985), Wetherill (1985), and subsequent work by Milani et al. (1989) indicate that the 3:1 Kirkwood gap is the most probable source region for the majority of ordinary chondrite meteorites. The diversity of the reflectance spectra among this small data set is surprising. Early work by Gaffey and McCord (1978) showed that the inner region of the main asteroid belt is dominated by high albedo objects with mafic silicate surfaces. One would expect to see mostly spectra with 1- and 2-micron absorption bands based on this earlier work. Only 5 (of 12) spectra have these expected features. The distribution of taxonomic types presented by Gradie and Tedesco (1982) is in most cases a useful simplification of the compositional structure of the asteroid belt. The range of spectral characteristics seen with higher resolution in the near-IR has not been previously reported and is not represented in the standard asteroid taxonomy. Near-IR spectra contain valuable mineralogical information which enhances knowledge of the composition and structure of asteroids. Author

**N93-19211*#** Adam Mickiewicz Univ., Poznan (Poland). Astronomical Observatory.

**SPIN VECTORS OF ASTEROIDS 21 LUTETIA, 196 PHILOMELA, 250 BETTINA, 337 DEVOSA, AND 804 HISPANIA**

Tadeusz Michalowski *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 417-419 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Such parameters as shape, orientation of spin axis, prograde or retrograde rotation are important for understanding the collisional evolution of asteroids since the primordial epochs of solar system history. These parameters remain unknown for most asteroids and poorly constrained for all but a few. This work presents results for five asteroids: 21, 196, 250, 337, and 804. Author

**N93-19212*#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany). German Aerospace Research Establishment.

**GROUND-BASED OBSERVATIONS OF 951 GASPRA: CCD LIGHTCURVES AND SPECTROPHOTOMETRY WITH THE GALILEO FILTERS** **c89**

Stefano Mottola, M. DiMartino (Osservatorio Astronomico, Turin, Italy ), M. Gonano-Beurer, H. Hoffmann, and G. Neukum *In* Lunar and Planetary Inst. Asteroids, Comets, Meteors 1991 1992 p 421-424 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

This paper reports the observations of 951 Gaspra carried out at the European Southern Observatory (La Silla, Chile) during the 1991 apparition, using the DLR CCD Camera equipped with a spare set of the Galileo SSI filters. Time-resolved spectrophotometric measurements are presented. The occurrence of spectral variations with rotation suggests the presence of surface variegation. Author

**N93-19213*#** Kitt Peak National Observatory, Tucson, AZ.

**CCD-PHOTOMETRY OF COMETS AT LARGE HELIOCENTRIC DISTANCES** **c89**

Beatrice E. A. Mueller *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 425-428 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

CCD imaging and time series photometry are used to determine the state of activity, nuclear properties and eventually the rotational motion of cometary nuclei. Cometary activity at large heliocentric distances and mantle evolution are not yet fully understood. Results of observations carried out at the 2.1 telescope on Kitt Peak April 10-12 and May 15-16, 1991 are discussed. Color values and color-color diagrams are presented for several comets and asteroids. Estimations of nuclear radii and shapes are given. Author

**N93-19214*#** Lowell Observatory, Flagstaff, AZ.

**ASTEROID ORBITAL ERROR ANALYSIS: THEORY AND APPLICATION** **c13**

K. Muinonen and Edward Bowell *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 429-432 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

We present a rigorous Bayesian theory for asteroid orbital error estimation in which the probability density of the orbital elements is derived from the noise statistics of the observations. For Gaussian noise in a linearized approximation the probability density is also Gaussian, and the errors of the orbital elements at a given epoch are fully described by the covariance matrix. The law of error propagation can then be applied to calculate past and future positional uncertainty ellipsoids (Cappellari et al. 1976, Yeomans et al. 1987, Whipple et al. 1991). To our knowledge, this is the first time a Bayesian approach has been formulated for orbital element estimation. In contrast to the classical Fisherian school of statistics, the Bayesian school allows a priori information to be formally present in the final estimation. However, Bayesian estimation does give the same results as Fisherian estimation when no priori information is assumed (Lehtinen 1988, and reference therein). Author

**N93-19215*#** Tokyo Astronomical Observatory, Mitaka (Japan). National Astronomical Observatory.
**LONG-TERM ORBITAL EVOLUTION OF SHORT-PERIOD COMETS FOUND IN PROJECT COSMO-DICE** **c13**
Tsuko Nakamura and Makoto Yoshikawa (Ministry of Posts and Telecommunications, Kashima, Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 433-438 (For primary document see N93-19113 06-90)
Avail: CASI HC A02/MF A04

Orbital evolutions of about 160 short-period (SP) comets are numerically integrated for 4400 years in the framework of a realistic dynamical model. By the round-trip error in closure test, a reliable time space of the integrated orbits is estimated for each comet. Majority of the SP comets with their Tisserand's constant(J) between 2.8 and 3.1 are found to evolve within the past 1000-2000 years from the orbits whose perihelia are near the Jovian orbit to the orbits with perihelia of 1-2 AU. This evolution is much more rapid than that expected from Monte Carlo simulations based on symmetric distribution of planetary perturbations, thus suggesting that asymmetry of perturbation distribution play an important role in cometary evolution. Several comets are shown to evolve from the near-Saturn orbits and then to be handed over under the control of Jupiter. We also find that a few comets were captured from long-period orbits (a = 75-125 AU) via only a few close encounters with Jupiter. It is confirmed that the captured SP comets of low-inclination with 2.7 less than J less than 3.1 show more or less strong chaotic behavior. On the other hand, comets with longer orbital period and/or of high inclination reveal slow or quasi-periodic orbital evolution. Author

**N93-19216*#** Observatoire de la Cote d'Azur, Nice (France).
**ROTATIONAL BEHAVIOR OF COMET NUCLEI UNDER GRAVITATIONAL PERTURBATIONS**
Pascal Oberti (Observatoire du Mont-Gros, Nice, France ), E. Bois (Observatoire des Alpes Maritimes, Grasse, France ), and Claude Froeschle (Observatoire du Mont-Gros, Nice, France ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 439-442 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A dynamical qualitative study of the rotational motion for cometary-type bodies submitted to gravitational perturbations has been performed by numerical simulations, including the Sun and Jupiter's disturbing torques in the model. Results show small gravitational disturbing effects from the Sun on Halley-type orbits, as well as from Jupiter on most close-approach configurations. Only a very close-approach induces notable effects, presenting then some interesting sensitivity to initial conditions. Author

**N93-19217*#** Lowell Observatory, Flagstaff, AZ.
**15 YEARS OF COMET PHOTOMETRY: A COMPARATIVE ANALYSIS OF 80 COMETS** **c89**
David J. Osip (Florida Univ., Gainesville.), David G. Schleicher, Robert L. Millis, M. F. A. Hearn (Maryland Univ., College Park.), and P. V. Birch (Perth Observatory, Australia ) *In* Lunar and Planeraty Inst., Asteroids, Comets, Meteors 1991 1992 p 443-445 (For primary document see N93-19113 06-90)
(Grants NAGw-2366; NSF AST-87-18087)
Avail: CASI HC A01/MF A04

In 1976 we began a program of narrowband photometry of comets that has encompassed well over 400 nights of observations. To date, the program has provided detailed information on 80 comets, 11 of which have been observed on multiple apparitions. In this paper we present the observed range of compositions (molecular production rate ratios) and dustiness (gas production compared with AF-rho) for a well sampled group of comets. Based on these results we present preliminary analysis of taxonomic groupings as well as the abundance ratios we associate with a 'typical' comet. Author

**N93-19218*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE SHAPE OF ASTEROID 1917 CUYO**
Steven J. Ostro and Wielaw Z. Wisniewski (Arizona Univ., Tucson.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 447-450 (For primary document see N93-19113 06-90)
(Grant NAGw-716)
Avail: CASI HC A01/MF A04

Lightcurves obtained for 1917 Cuyo at solar phase angles near 54 degrees have an amplitude delta m = 0.44 mag. However, convex-profile inversion of the lightcurves yields an estimate of the asteroid's mean cross section (C, a 2-D average of the 3-D shape) that is only slightly noncircular, with an elongation approximately 1.15. The estimate of C undoubtedly contains systematic errors, the most severe of which could arise from non-equatorial viewing/illumination geometry. However, Cuyo's radar echo shows very little variation in bandwidth vs. rotation phase, supporting the hypothesis that this asteroid's elongation is rather modest. Author

**N93-19219*#** Institut Royal Meteorologique de Belgique, Brussels.
**THE IMPORTANCE OF GUIDING ON THE MOTION OF A COMET IN ASTROMETRIC OBSERVATIONS** **c89**
Thierry Pauwels *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 451-454 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

In this paper we discuss the influence of guiding on the motion of a comet on the derived astrometric position. Author

**N93-19220*#** Institut Royal Meteorologique de Belgique, Brussels.
**A NEW METHOD FOR ASTROMETRIC OBSERVATIONS OF ASTEROIDS** **c89**
Thierry Pauwels *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 455-458 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

In this paper we propose a new method for photographic astrometric observations of asteroids. We discuss its advantages and disadvantages and compare them to the advantages and disadvantages of the classical photographic methods. The new method is best suited for observations on a spot where no CCD cameras, blink or stereo comparators are available and when a fast detection of unknown objects is required. Author

**N93-19221*#** California Univ., Santa Barbara. Dept. of Physics.
**ON LAM'S AND SAM'S FOR HALLEY'S ROTATION**
Stanton J. Peale *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 459-467 (For primary document see N93-19113 06-90)
(Grant NAGw-2061)
Avail: CASI HC A02/MF A04

Non principal axis rotation for comet Halley is inferred from dual periodicities evident in the observations. The modes where the spin axis precesses around the axis of minimum moment of inertia (long axis mode or LAM) and where it precesses around the axis of maximum moment of inertia (short axis mode or SAM) are described from an inertial point of view. The currently favored LAM model for Halley's rotation state satisfies observational and dynamical constraints that apparently no SAM can satisfy. But it cannot reproduce the observed post perihelion brightening through seasonal illumination of localized sources on the nucleus, whereas a SAM can easily produce post or pre perihelion brightening by this mechanism. However, the likelihood of a LAM rotation for elongated nuclei of periodic comets such as Halley together with Halley's extreme post perihelion behavior far from the Sun suggest that Halley's post perihelion brightening may be due to effects other than seasonal illumination of localized sources, and therefore such brightening may not constrain its rotation state. Author

**N93-19222*#** Slovak Academy of Sciences, Bratislava (Czechoslovakia).
**BURST OF THE 1969 LEONIDS AND 1982 LYRIDS**
V. Porubcan and Jan Stohl *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 469-472 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Radar observations of the last bursts of the Leonids in 1969 and Lyrids in 1982, carried out at the Springhill Meteor Observatory, Canada, both of very short duration, with the rates exceeding a quarter-maximum rate within 50-55 minutes, are used for a study of the mass distribution of meteoroids. In both cases the mass distribution exponents of the meteoroids in the dense clouds largely differ from the values obtained for the older populations of the streams. The highest mass exponent s approximately 2.2-2.4 is found around the peak of the activity, confirming high contribution

of smaller meteoroids, and thus also a recent origin of the dense clouds. Consequences of these findings are discussed. Author

**N93-19223*#** Slovak Academy of Sciences, Bratislava (Czechoslovakia). Astronomical Inst.

**ON ASSOCIATIONS OF APOLLO ASTEROIDS WITH METEOR STREAMS**

V. Porubcan, Jan Stohl, and R. Vana (Comenius Univ., Bratislava, Czechoslovakia ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 473-476 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Potential associations of Apollo asteroids with meteor streams are searched on the basis of the orbital parameters comparison. From all Apollo asteroids discovered through 1991 June those are only selected for further analysis whose orbits approach to less than 0.1 AU to the Earth's orbit. Their orbits are compared with precise photographic orbits of individual meteors from the Meteor Data Center in Lund. Results on the associations of asteroids with meteor streams are presented and discussed. Author

**N93-19224*#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).

**OBSERVATIONS OF COMET LEVY 1990c IN THE (OI) 6300-A LINE WITH AN IMAGING FABRY-PEROT** **c89**

C. Debi Prasad, Klaus Jockers, H. Rauer, and E. H. Geyer (Observatorium Hoher List, Daun, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 477-480 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

We have observed the comet Levy 1990c during 16-25 August 1990 using the MPAE focal reducer system based Fabry-Perot etalon coupled with the 1 meter telescope of the Observatory of Hoher List. The free spectral range and resolution limit of the interferometer was approximately 2.18 A and approximately 0.171 A respectively. Classical Fabry-Perot fringes were recorded on a CCD in the cometary (OI) 6300 A line. They are well resolved from telluric air glow and cometary NH2 emission. Our observations indicate that the (OI) is distributed asymmetrically with respect to the center of the comet. In this paper we report the spatial distribution of (OI) emission and its line width in the coma of comet Levy. Author

**N93-19225*#** Arizona Univ., Tucson. Lunar and Planetary Lab.

**THE FLUX OF SMALL ASTEROIDS NEAR THE EARTH**

David L. Rabinowitz *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 481-485 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Fifteen new EA's (Earth approachers) have been discovered since September, among them the smallest asteroids on record: 1990 UN, 1991 BA, and 1991 JR, which are in the 10 to 100 m size range (Scotti et al. 1991b). For the first time, we can make estimates of the fluxes near the Earth of these small objects, thought to be the immediate parents of meteorites, from direct observation. In this paper, I show that for EA's larger than a few 100 m, the magnitude-frequency dependence we observe is consistent with the cumulative magnitude-frequency relation, m(H), established for the main belt asteroids. Assuming this relation extends to smaller sizes, however, the probability for discovering both 1990 UN and 1991 JR was 15 percent, and for discovering 1991 BA only 1 percent. Objects smaller than approx. 100 m are therefore increasingly overabundant compared to an extrapolation from larger objects, with the excess increasing with decreasing size. Near 10 m, the most probable flux near the Earth is two orders of magnitude higher. This is in agreement with the flux extrapolated from observations of bright meteors and fireballs. It is thus likely that processes other than collisional breakup of asteroidal material begin to supply the population of small objects near the Earth at sizes near 100 m. Tantalizing clues from spectral measurements and orbital associations suggest that these objects may be the debris from extinct, short-period comets. Author

**N93-19226*#** Indian Inst. of Astrophysics, Bangalore.

**NARROW BAND PHOTOMETRY OF SELECTED ASTEROIDS** **c89**

R. Rajamohan and S. G. Bhargavi *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 487-491 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

The CCD photometry of selected asteroids was carried out to check for possible cometary activity in them. To distinguish the asteroids with possible cometary activity from those of the main belt, each object of interest was observed in two filters; one centered on the C2 emission band at 5140A (90A bandpass) and the other centered on the nearby continuum at 4845A (65A bandpass). None of the observed asteroids appear to have any C2 emission. Author

**N93-19227*#** Colorado Univ., Boulder. Lab. for Atmospheric and Space Physics.

**THE DISCONNECTION EVENT OF 16.0 MARCH 1986 IN COMET HALLEY**

Cora E. Randall, John C. Brandt, Y. Yi, and M. Snow *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 493-495 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

From kinematic extrapolation of tail/nucleus distance measurements on photographic images in the International Halley Watch (IHW) archive, we calculated the disconnection time of the 16-19 March 1986 event to be 16.0 (plus or minus 0.1) March. The solar wind conditions around Comet Halley at the time of the DE, inferred by corotation of IMP-8 satellite data to the comet, were such that (1) Comet Halley had just crossed the interplanetary magnetic field (IMF) sector boundary; (2) the solar wind density was approximately 8 cm(exp -3); (3) the solar wind speed was approximately 600 km/sec; (4) the IMF magnitude was approximately 8 nT. Given these conditions, we conclude that the most likely cause of the 16.0 March DE was front-side magnetic reconnection, as described in the model of Niedner and Brandt (1978). Author

**N93-19228*#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Inst. fuer Raumsimulation.

**LABORATORY STUDIES ON COMETARY CRUST FORMATION: THE IMPORTANCE OF SINTERING**

L. Ratke, Hermann Kochan, and H. Thomas *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 497-500 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

It is demonstrated by experiments and theoretical considerations that sintering processes, so far used to describe the densification of metal and ceramic powders, are relevant for icy materials and therefore probably also for comets. A theoretical model is presented which describes the evolution of so called sinter necks, the contact zone between ice particles. With this model the strength increase of a porous, loosley packed icy body is calculated in which the sinter necks grow by evaporation and condensation of water vapor at a constant temperature. Experiments with ice powders validate the model qualitatively. An increase in strength up to a factor of four is observed during isothermal sintering. In order to check the relevance of the experimental results and the basic theoretical ideas with respect to real comets, more exact theories and improved experiments taking into account additional mass transport mechanisms are needed. Author

**N93-19229*#** International Meteor Organization, Potsdam (Germany).

**VISUAL DATA OF MINOR METEOR SHOWERS LIMITS OF THE METHOD**

Jurgen Rendtel and R. Koschack *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 501-504 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Visual meteor observations are carried out on a regular basis by many experienced observers worldwide, thus supplying information about activity of meteor showers. The limits of the method are determined by the accuracy of the detection of the meteor trail. This study shows that visual meteor observations provide reliable data for an observable hourly rate of greater than or equal to 3. Author

**N93-19230*#** Notre Dame Univ., IN.

**LONG SLIT SPECTROSCOPY OF NH2 IN COMETS HALLEY, WILSON, AND NISHIKAWA-TAKAMIZAWA-TAGO** **c89**

Terrence W. Rettig, Stephen C. Tegler, Susan Wyckoff (Arizona State Univ., Tempe.), Rodney Heyd (Arizona State Univ., Tempe.), Raylee Stathkis (Anglo-Australian Observatory, Epping.), and D. A. Ramsay (Herzberg Inst. of Astrophysics, Pentiction, British Columbia ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 505-508 Sponsored in part by NSF (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Long-slit spectra of comets Halley, Wilson and Nishikawa-Takamizawa-Tago were obtained with the 3.9 meter Anglo-Australian Telescope. Spectra of comets Halley and Wilson were obtained with the IPCS at a spectral resolution of 0.5 A and a spatial resolution of 10(exp 3) km. Spectra of comets Wilson and Nishikawa-Takamizawa-Tago were obtained with a CCD at a spectral resolution of 1.5 A and a spatial resolution of approximately 3 x 10(exp 3) km. Surface brightness profiles for NH2 were extracted from the long-slit spectra of each comet. The observed surface brightness profiles extend along the slit to approximately 6 x 10(exp 4) km from the nucleus in both sunward and tailward directions. By comparing surface distribution calculated from an appropriate coma model with observed surface brightness distributions, the photodissociation timescale of the parent molecule of NH2 can be inferred. The observed NH2 surface brightness profiles in all three comets compares well with a surface brightness profile calculated using the vectorial model, an NH3 photodissociation timescale of 7 x 10(exp 3) seconds, and an NH2 photodissociation timescale of 34,000 seconds. Author

**N93-19231*#** Astronomical Observatory, Uppsala (Sweden).
**TWENTIETH CENTURY LIGHT CURVES AND THE NUCLEUS OF COMET P/TEMPEL 2** **c89**
Hans Rickman, Michel C. Festou (Observatoire de Midi-Pyresnees, Toulouse, France ), Gonzalo Tancredi, and L. Kamel *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 509-512 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Observations of P/Tempel 2 from 1899 to 1988 corresponding to 13 apparitions are analyzed in order to estimate the perihelion asymmetry of the gas production curve for different periods of its evolution. Using the correlation found by Festou et al. (1990) between the perihelion asymmetries and the delay in perihelion passage due to the action of nongravitational forces, we estimate the mass of the comet to be M approximately equals 1.6 plus or minus 0.5 x 10(exp 14) kg. Assuming a volume of 500 cu km, based on nuclear observations, a density of 0.3 plus or minus 0.1 g/cu cm is obtained. Author

**N93-19232*#** New Mexico Univ., Albuquerque. Dept. of Geology.
**CARBON PETROLOGY IN COMETARY DUST**
Frans J. M. Rietmeijer *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 513-516 (For primary document see N93-19113 06-90)
(Grant NAG9-160)
Avail: CASI HC A01/MF A04

Chondritic porous (CP) interplanetary dust particles (IDP's) are collected in the Earth's stratosphere. There exists an extensive database on major and minor element chemistry, stable isotopes, noble gas abundances and mineralogy of many CP IDP's, as well as infrared and Raman spectroscopic properties. For details on the mineralogy, chemistry and physical properties of IDP's, I refer to the reviews by Mackinnon and Rietmeijer (1987), Bradley et al. (1988) and Sandford (1987). Texture, mineralogy (Mackinnon and Rietmeijer, 1987) and chemistry (Schramm et al., 1989; Flynn and Sutton, 1991) support the notion that CP IDP's are a unique group of ultrafine-grained extraterrestiral materials that are distinct from any known meteorite class. Their fluffy, or porous, morphology suggests that CP IDP's probably endured minimal alteration by protoplanetary processes since their formation. It is generally accepted that CP IDP's are solid debris from short-period comets. The evidence is mostly circumstantial but this notion gained significant support based on the comet Halley dust data (Brownlee, 1990). In this paper, I will accept that CP IDP's are indeed cometary dust. The C/Si ratio in CP IDP's is 3.3 times higher than in CI carbonaceous chondrites (Schramm et al. 1989). The intraparticle carbon distribution is heteorogeneous (Rietmeijer and McKay, 1986). Carbon occurs both in oxidized and reduced forms. Analytical electron microscope (AEM) and Raman spectroscopic analyses have shown the presence of several carbon forms in CP IDP's but the data are scattered in the literature. Carbons in cometary CP IDP's are among the most pristine Solar System carbons available for laboratory study. Similar to a recently developed petrological model for the diversity of layer silicates in CP IDP's (Zolensky, 1991) that is useful to constrain in situ aqueous alteration in comets (Rietmeijer and Mackinnon, 1987a), I here present the first effort to develop a petrological concept of carbons in CP IDP's. This concept is useful to constrain comet evolution. I also present the philosophical constraint facing Earth Scientists in studies of protoplanets that require a new approach to cometary dust studies. Author

**N93-19233*#** Mount Allison Univ., Sackville (New Brunswick). Dept. of Physics.
**WAKE IN FAINT TELEVISION METEORS**
M. C. Robertson and Robert L. Hawkes *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 517-520 Sponsored by Natural Sciences and Engineering Research Council and Bell Canada Enterprises Mobile, Inc. (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The two component dustball model was used in numerical lag computation. Detached grain lag is typically less than 2 km, with expected wakes of a few hundred meters. True wake in television meteors is masked by apparent wake due to the combined effects of image persistence and blooming. To partially circumvent this problem, we modified a dual MCP intensified CID video system by addition of a rotating shutter to reduce the effective exposure time to about 2.0 ms. Preliminary observations showed that only 2 of 27 analyzed meteors displayed statistically significant wake. Author

**N93-19234*#** Forschungszentrum Juelich G.m.b.H. (Germany). Inst. fuer Nuklearchemie.
**CHEMICAL AND PHYSICAL EFFECTS IN THE BULK OF COMETARY ANALOGS**
K. Roessler, Jean Benit, and M. Sauer *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 521-524 Sponsored in part by DFG (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

KOSI comet simulation experiments were designed as a macroscopic tester for the studies of physicochemical problems inherent to comet bodies. The analog samples consist of H2O and CO2 ice, organic admixtures, mineral dust, and carbon. Two of the fundamental changes the analogs undergo when submitted to 'insolation' by artificial sunlight, i.e., the diffusion of frozen gases and subsequent crust formation and the natural isotopic fractionation, are reported. Author

**N93-19235*#** Observatoire de Besancon (France).
**EVOLUTION OF NEAR UV HALLEY'S SPECTRUM IN THE INNER COMA**
Phillippe Rousselot, Jacques Clairemidi, F. Vernotte, and Guy Moreels *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 525-528 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A direct way to observe the photodissociation of water vapor in a cometary coma is to detect the OH prompt emission. This emission is shifted of delta lambda = 4 nm with respect to the OH 309 nm fluorescence band. The extended data set obtained with the three-channel spectrometer on-board Vega 2 reveals at short distance of the nucleus (i.e., less than 600 km) an excess of emission on the right wing of the OH band which may be interpreted as being mainly due to prompt emission. Author

**N93-19236*#** Tohoku Univ., Sendai (Japan). Geophysical Inst.
**MOSAIC CCD METHOD: A NEW TECHNIQUE FOR OBSERVING DYNAMICS OF COMETARY MAGNETOSPHERES** **c89**
T. Saito, H. Takeuchi, Y. Kozuba, S. Okamura (Tokyo Univ., Mitake, Japan), I. Konno (Southwest Research Inst., San Antonio, TX.), M. Hamabe (Tokyo Univ., Mitake, Japan ), T. Aoki, S. Minami (Osaka Univ., Japan ), and S. Isobe (Tokyo Univ., Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 529-532 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

On April 29, 1990, the plasma tail of Comet Austin was observed with a CCD camera on the 105-cm Schmidt telescope at the Kiso Observatory

of the University of Tokyo. The area of the CCD used in this observation is only about 1 sq cm. When this CCD is used on the 105-cm Schmidt telescope at the Kiso Observatory, the area corresponds to a narrow square view of 12 ft x 12 ft. By comparison with the photograph of Comet Austin taken by Numazawa (personal communication) on the same night, we see that only a small part of the plasma tail can be photographed at one time with the CCD. However, by shifting the view on the CCD after each exposure, we succeeded in imaging the entire length of the cometary magnetosphere of 1.6 x 10(exp 6) km. This new technique is called 'the mosaic CCD method'. In order to study the dynamics of cometary plasma tails, seven frames of the comet from the head to the tail region were twice imaged with the mosaic CCD method and two sets of images were obtained. Six microstructures, including arcade structures, were identified in both the images. Sketches of the plasma tail including microstructures are included. Author

**N93-19237*#** Five-College Astronomy Dept., Amherst, MA. Dept. of Physics and Astronomy.

**SUBMILLIMETER MOLECULAR LINE OBSERVATIONS OF COMETARY LEVY (1990c)** **c89**

F. Peter Schloerb and Weiguo Ge *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 533-536 (For primary document see N93-19113 06-90)

(Grant NAGw-1483)

Avail: CASI HC A01/MF A04

Observations of HCN and H2CO in Comet Levy (1990c) obtained at the Caltech Submillimeter Observatory during August 1990 are presented. The HCN J=3-2 rotational line was measured at high spectral resolution (0.1 km/s) and mapped at 13 points over a region of approximately 1.5 arcmin. Analysis of the line profile and the map suggest only slight deviations from the distribution expected for isotropic outgassing of HCN from the nucleus at a velocity of 0.7 plus or minus 0.1 km/s. Observations of the HCN J=4-3 and H2CO5(sub 15)4(sub 14) transitions were obtained simultaneously on two days following the HCN J=3-2 measurements. These transitions are the first submillimeter spectral lines to be detected in a comet. Five point maps of the emission show good consistency between the J=3-2 and J=4-3 HCN observations for an HCN production rate of 2 x 10(exp 26) and a rotational temperature of approximately 30 K. The map of H2CO emission indicates that it is more extended than the prediction of models in which H2CO originates entirely from the nucleus. H2CO may also originate from an extended source in the coma. Author

**N93-19238*#** Bochum Univ. (Germany). Astronomisches Inst.

**SPATIAL AND TEMPORAL VARIATIONS IN THE COLUMN DENSITY DISTRIBUTION OF COMET HALLEY'S CN COMA**

Rita Schulz, W. Schlosser, W. Meisser, P. Koczet, and W. E. Celnik (Wilhelm-Foerster-Sternwarte, Berlin, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 537-540 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Mean radial column density profiles of comet P/Halley's CN coma were derived by combining photographic and photoelectric observations. The shape of the profiles as well as their temporal variations were analyzed in detail and compared with the results of other CN observations of the comet. Author

**N93-19239*#** Arizona Univ., Tucson. Lunar and Planetary Lab.

**AUTOMATED DETECTION OF ASTEROIDS IN REAL-TIME WITH THE SPACEWATCH TELESCOPE** **c89**

James Vernon Scotti, T. Gehrels, and David L. Rabinowitz *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 541-544 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

The Spacewatch telescope on Kitt Peak is being used to survey for near-earth asteroids using a Tektronix TK2048 CCD in scanning mode. We hope to identify suitable low delta v candidates amongst the near-earth asteroid population as possible exploration targets, to identify those objects which pose a danger to life on earth, and to study the physical properties of the objects in near-earth space. Between Sep. 1990 and Jun. 1991, 14 new earth-approaching asteroids including 1 Aten, 9 Apollo, and 4 Amor type asteroids were detected by automated software and discriminated by their angular rates from the rest of the detected asteroids in near-real time by the observer. The average of about 1.5 earth-approaching asteroids per month is comparable to the total number found by all other observatories combined. One other Apollo type asteroid was detected by the observer as a long trailed image. The positions of this last object were measured and the object was tracked by the observer in real time. This object was determined to be a 5-10 meter diameter object which passed within 170,000 kilometers of earth. Of the 14 automatically detected earth-approaching asteroids, 10 have been found at distances in excess of 0.5 AU from earth. An average of more than 2000 asteroids are detected each month. Positions, angular rates, and brightnesses are determined for each of these asteroids in real-time. Author

**N93-19240*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**SUBLIMATION RATES OF CARBON MONOXIDE AND CARBON DIOXIDE FROM COMETS AT LARGE HELIOCENTRIC DISTANCES**

Zdenek Sekanina *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 545-548 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

Using a simple model for outgassing from a small flat surface area, the sublimation rates of carbon monoxide and carbon dioxide, two species more volatile than water ice that are known to be present in comets, are calculated for a suddenly activated discrete source on the rotating nucleus. The instantaneous sublimation rate depends upon the comet's heliocentric distance and the Sun's zenith angle at the location of the source. The values are derived for the constants of CO and CO2 in an expression that yields the local rotation-averaged sublimation rate as a function of the comet's spin parameters and the source's cometocentric latitude. Author

**N93-19241*#** Kharkov State Univ. (USSR). Astronomical Observatory.

**INTERPRETING ASTEROID PHOTOMETRY AND POLARIMETRY USING A MODEL OF SHADOWING AND COHERENT BACKSCATTERING** **c89**

Y. G. Shkuratov and Karri Muinonen (Lowell Observatory, Flagstaff, AZ.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 549-552 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

The shadow-hiding models for the opposition effect and negative polarization of atmosphereless solar system bodies do not explain some experimental findings, such as the enhancing opposition effect and negative polarization with decreasing particle size down to wavelength scales. The enhancement for laboratory photometric and polarimetric data on artificial glass samples with different particle size is shown. These results are in agreement with the so-called coherent backscattering or interference mechanism proposed for the interpretation of the opposition effect and negative polarization. Two different approaches for describing the opposition effect and negative polarization produced by the shadow-interference mechanism were developed. One is based on exact electromagnetic solutions for simple scattering systems that include dipole-dipole and dipole-surface coupling; The other is based on a point-scatterer approximation characterized by model photometric and polarimetric phase functions, and the mutual shadowing effect is derived using virtual volumes associated with the point-scatterers. Both approaches yield qualitatively similar results, although neither is entirely satisfactory. We regard them as prototypes for a future unified model of shadowing and coherent backscattering. The sharp opposition effect of 44 Nysa and the asteroid albedo-polarization rule are here explained using the point-scatterer approach. Author

**N93-19242*#** Academy of Sciences (USSR), Perm. Inst. of Theoretical Astronomy.

**ON THE DISTRIBUTION OF MINOR PLANET INCLINATIONS** **c13**

Viktor A. Shor and Eleonora I. Yagudina *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 553-556 (For primary document see N93-19113 06-90)

Avail: CASI HC A01/MF A04

The distribution of minor planet orbits with inclination to the ecliptic plane and with respect to the Jupiter orbit is studied. Position of the plane considered as the mean plane of the asteroid belt is determined. Author

**N93-19243*#** Ceskoslovenska Akademie Ved, Ondrejov. Astronomical Inst.

**DIURNAL VARIATION OF OVERDENSE METEOR ECHO DURATION AND OZONE**

Milos Simek *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 557-560 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The diurnal variation of the median duration of overdense sporadic radar meteor echoes is examined. The meteors recorded in August, December, and January by the Ondrejov meteor radar during the period 1958-1990 were used for the analysis. A maximum median echo duration 1-3 hours after the time of local sunrise in the meteor region confirms the already known sunrise effect. Minimum echo duration occurring at the time of sunset seems to be the most important point of diurnal variation of the echo duration, when ozone is no longer dissociated by solar UV radiation. The effect of diurnal changes of the echo duration should be considered when the mass distribution of meteor showers is analyzed. Author

**N93-19244*#** California Inst. of Tech., Pasadena. Lab. of Experimental Geophysics.

**MELTING, VAPORIZATION, AND ENERGY PARTITIONING FOR IMPACTS ON ASTEROIDAL AND PLANETARY OBJECTS**

Catherine L. Smither and Thomas J. Ahrens *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 561-564 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A three-dimensional smoothed particle hydrodynamics code was used to model normal and oblique impacts of silicate projectiles on asteroidal and planetary bodies. The energy of the system, initially in the kinetic energy of the impactor, is partitioned after impact into internal and kinetic energy of the impactor and the target body. These simulations show that, unlike the case of impacts onto a half-space, a significant amount of energy remains in the kinetic energy of the impacting body, as parts of it travel past the main planet and escape the system. This effect is greater for more oblique impacts, and for impacts onto the small planets. Melting and vaporization of both bodies were also examined. The amount of the target body melted was much greater in the case of smaller targets than for an impact of a similar scale on a larger body. Author

**N93-19245*#** Sternberg Astronomical Inst., Moscow (USSR). Dept. of Celestial Mechanics.

**3-D ORBITAL EVOLUTION MODEL OF OUTER ASTEROID BELT**

Nina A. Solovaya, Igor A. Gerasimov, and Eduard M. Pittich (Slovak Academy of Sciences, Bratislava, Czechoslovakia ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 565-568 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The evolution of minor planets in the outer part of the asteroid belt is considered. In the framework of the semi-averaged elliptic restricted three-dimensional three-body model, the boundary of regions of the Hill's stability is found. As was shown in our work, the Jacobian integral exists. Author

**N93-19246*#** Anglo-Australian Services of Botswana, Gaborone.

**THE TAPANUI REGION OF NEW ZEALAND: SITE OF A TUNGUSKA AROUND 800 YEARS AGO?**

Duncan Steel and Peter Snow (Snow, Peter, Tapanui, New Zealand ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 569-572 Sponsored by Australian Research Council (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Evidence is discussed that the wide-spread fires ca. 800 years ago which denuded the southern provinces of the South Island of New Zealand of the extensive forests present at that time were due to the entry of a large bolide into the atmosphere, the conflagration being ignited by the intense heat generated as this extraterrestrial projectile ablated/detonated in a similar manner to that of the Tunguska object of 1908. These fires led to the extinction of the giant terrestrial bird known as the Moa, and the end of the archaic epoch of Maori history known as the Moa Hunter period. This interpretation is well attested to in Maori myth and legend. Author

**N93-19247*#** Anglo-Australian Services of Botswana, Gaborone.

**1991 DA: AN ASTEROID IN A BIZARRE ORBIT**

Duncan Steel, Robert H. McNaught, and David Asher (Oxford Univ., England) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 573-576 Sponsored by Australian Research Council and Science Research Council (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Asteroidal object 1991 DA has an orbit of high inclination, crossing the planets from Mars to Uranus. This is unique for an asteroid, but not unusual for a comet of the Halley-type: it therefore seems likely that 1991 DA is an extinct or dormant comet. Previous CCD imaging has shown no indication of a coma; spectroscopic observations of 1991 DA which lack any evidence of strong comet-like emissions are reported. Numerical integrations of the orbit of this object were performed which show that is has been remarkably stable for the past approximately 20,000 yr, but chaotic before that. This may allow a new estimate to be made of the physical lifetimes of comets. Author

**N93-19248*#** Southwest Research Inst., San Antonio, TX. Space Sciences Dept.

**A CCD SEARCH FOR DISTANT SATELLITES OF ASTEROIDS 3 JUNO AND 146 LUCINA** **c89**

S. Alan Stern and Edwin S. Barker (McDonald Observatory, Fort Davis, TX.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 577-581 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The results of CCD searches for satellites of asteroids 146 Lucina and 3 Juno are reported. Juno is one of the largest asteroids (D = 244 km); no previous deep imaging search for satellites around it has been reported. A potential occultation detection of a small satellite orbiting 146 Lucina (D = 137 km) km was reported by Arlot et al. (1985), but has not been confirmed. Using the 2.1 m reflector at McDonald Observatory in 1990 and 1991 with a CCD camera equipped with a 2.7 arc-sec radius occulting disk, limiting magnitudes of m(sub R) = 19.5 and m(sub R) = 21.4 were achieved around these two asteroids. This corresponds to objects of 1.6 km radius at Juno's albedo and distance, and 0.6 km radius at Lucina's albedo and distance. No satellite detections were made. Unless satellites were located behind our occultation mask, these two asteroids do not have satellites larger than the radii given above. Author

**N93-19249*#** University of Western Ontario, London. Dept. of Geography.

**CARTOGRAPHY OF ASTEROIDS AND COMET NUCLEI FROM LOW RESOLUTION DATA**

Philip J. Stooke *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 583-586 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

High resolution images of non-spherical objects, such as Viking images of Phobos and the anticipated Galileo images of Gaspra, lend themselves to conventional planetary cartographic procedures: control network analysis, stereophotogrammetry, image mosaicking in 2D or 3D, and airbrush mapping. There remains the problem of a suitable map projection for bodies which are extremely elongated or irregular in shape. Many bodies will soon be seen at lower resolution (5-30 pixels across the disk) in images from speckle interferometry, the Hubble Space Telescope, ground-based radar, distinct spacecraft encounters, and closer images degraded by smear. Different data with similar effective resolutions are available from stellar occultations, radar or lightcurve convex hulls, lightcurve modeling of albedo variations, and cometary jet modeling. With such low resolution, conventional methods of shape determination will be less useful or will fail altogether, leaving limb and terminator topography as the principal sources of topographic information. A method for shape determination based on limb and terminator topography was developed. It has been applied to the nucleus of Comet Halley and the jovian satellite Amalthea. The Amalthea results are described to give an example of the cartographic possibilities and problems of anticipated data sets. Author

**N93-19250*#** Arizona Univ., Tucson. Steward Observatory.

**THE NATURE OF COMET NUCLEI**

Mark V. Sykes and Russell G. Walker (Jamieson Science and Engineering, Inc., Scotts Valley, CA.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 587-591 (For primary document see N93-19113

06-90)
(Contract NAS5-30772; NAG5-1370)
Avail: CASI HC A01/MF A04

The icy-conglomerate model of comet nuclei has dominated all others since its introduction. It provided a basis for understanding the non-gravitational motions of comets which had perplexed dynamicists up to that time, and provided a focus for understanding cometary composition and origin. The image of comets as dirty snowballs was quickly adopted. Comet nuclei including their trail mass loss rates and refractory to volatile mass ratios are described. Author

**N93-19251*#** Polish Academy of Sciences, Warsaw. Space Research Centre.
**FORCED PRECESSION OF THE COMETARY NUCLEUS WITH RANDOMLY PLACED ACTIVE REGIONS**
Slawomira Szutowicz *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 593-596 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The cometary nucleus is assumed to be triaxial or axisymmetric spheroid rotating about its axis of maximum moment of inertia and is forced to precess due to jets of ejected material. Randomly placed regions of exposed ice on the surface of the nucleus are assumed to produce gas and dust. The solution of the heat conduction equation for each active region is used to find the gas sublimation rate and the jet acceleration. Precession of the comet nucleus is followed numerically using a phase-averaged system of equations. The gas production curves and the variation of the spin axis during the orbital motion of the comet are presented. Author

**N93-19252*#** Toho Gakuen Junior Coll. (Japan).
**VELOCITY DISTRIBUTION OF FRAGMENTS OF CATASTROPHIC IMPACTS**
Yasuhiko Takagi, Manabu Kato (Nagoya Univ., Japan ), and Hitoshi Mizutani (Tokyo Univ., Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 597-600 Sponsored by Ministry of Education, Science and Culture (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Three dimensional velocities of fragments produced by laboratory impact experiments were measured for basalts and pyrophyllites. The velocity distribution of fragments obtained shows that the velocity range of the major fragments is rather narrow, at most within a factor of 3 and that no clear dependence of velocity on the fragment mass is observed. The NonDimensional Impact Stress (NDIS) defined by Mizutani et al. (1990) is found to be an appropriate scaling parameter to describe the overall fragment velocity as well as the antipodal velocity. Author

**N93-19253*#** Astronomical Observatory, Uppsala (Sweden).
**THE VICINITY OF JUPITER: A REGION TO LOOK FOR COMETS**
Gonzalo Tancredi (Universidad de la Republica, Montevideo, Uruguay ) and Mats Lindgren *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 601-604 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Low-relative velocity and long-lasting encounters can dramatically change the orbital elements of a comet; the object could be temporarily bound to Jupiter for a period of several years. It is well stated that most of the discoveries of comets occurred just after a close encounter with the planet and a decrease of the perihelion distance of the comet. So, why don't we look for comets during close encounters with Jupiter rather than waiting to find them afterwards? To estimate the feasibility of this proposal, dynamical computations and observational analysis of the Jupiter family of comets were made. A criterion to distinguish comets during an encounter from other moving objects in the field is discussed. Author

**N93-19254*#** Polish Academy of Sciences, Warsaw. Space Research Centre.
**DETERMINATION OF ORBITS OF COMETS: P/KEARNS-KWEE, P/GUNN, INCLUDING NONGRAVITATIONAL EFFECTS IN THE COMETS' MOTION** **c13**
Bozenna Todorovic-Juchniewicz and Grzegorz Sitarski *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 605-608 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

To improve the orbits, all the positional observations of the comets were collected. The observations were selected and weighted according to objective mathematical criteria and the mean residuals a priori were calculated for both comets. We took into account nongravitational effects in the comets' motion using Marsden's method applied in two ways: either determining the three constant parameters, A(sub 1), A(sub 2), A(sub 3) or the four parameters A, eta, I, phi connected with the rotating nucleus of the comet. To link successfully all the observations, we had to assume for both comets that A(t) = A(sub O)exp(-B x t) where B was an additional nongravitational parameter. Author

**N93-19255*#** Meta Research, Washington, DC.
**MINOR SATELLITES AND THE GASPRA ENCOUNTER**
Thomas C. VanFlandern *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 609-612 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Observational evidence, especially from occultations and radar, indicate that satellites of minor planets are numerous and commonplace. This leads to the prediction that the Galileo spacecraft will find many such 'minor satellites' at the upcoming close encounter with minor planet 951 Gaspra. If such objects are found, this argues strongly against the current theory of minor planet origin from the primeval solar nebula. Author

**N93-19256*#** Karlova Univ., Prague (Czechoslovakia). Inst. of Astronomy.
**THE ROLE OF ORGANIC POLYMERS IN THE STRUCTURE OF COMETARY DUST**
Vladimir Vanysek, Hermann Boehnhardt (European Space Agency. European Space Operations Center, Darmstadt, Germany ), and H. Fechtig (Max-Planck-Inst. fuer Kernphysik, Heidelberg, Germany ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 613-615 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Several phenomena observed in P/Halley and other comets indicate additional fragmentation of dust particles or dust aggregates in cometary atmospheres. The disintegration of dust aggregates may be explained by sublimation of polymerized formaldehyde - POM - which play a role as binding material between submicron individual particles. Author

**N93-19257*#** Jamieson Science and Engineering, Inc., Felton, CA.
**HIGH RESOLUTION IMAGES OF P/TEMPEL 1 AND P/TEMPEL 2 CONSTRUCTED FROM IRAS SURVEY DATA** **c89**
Russell G. Walker, Humberto Campins (Florida Univ., Gainesville.), and Martin Schlapfer *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 617-620 (For primary document see N93-19113 06-90)
(Contracts NAS5-30772; NASw-1821)
Avail: CASI HC A01/MF A04

Infrared images of P/Tempel 1 and P/Tempel 2 were constructed from IRAS survey data using a computer algorithm based on the Maximum Correlation Method for Image Construction (Aumann et al, 1990). The resulting images are of sufficiently high quality and resolution to delineate coma and tail morphology, and permit accurate photometry of the total dust complex. Comparisons of the infrared colors and photometric profiles of Tempel 1 and Tempel 2 at similar heliocentric distances show that the grains produced by the two comets are quite similar in radiometric and dynamic properties. Tempel 1 is found to produce about 30 percent more dust in its coma and tail than Tempel 2. The comae of Tempel 1 and Tempel 2 are expanding with mean velocities of 5.8 plus or minus 0.07 and 6.1 plus or minus 0.17 m/sec respectively, indicative of the ejection of large grains. The IRAS cataloged infrared fluxes (Walker, 1986) are found to be underestimated by as much as a factor of three for the comets. Therefore, it is essential to create images of the comets to obtain meaningful IRAS photometry. Author

**N93-19258*#** Tokyo Univ. (Japan). National Astronomical Observatory.
**ROTATION OF SPLIT COMETARY NUCLEI**
Jun-Ichi Watanabe *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 621-624 (For primary document see N93-19113

06-90)
Avail: CASI HC A01/MF A04

A simple model for the rotational motion of split cometary nuclei is studied. A large-amplitude precession is easily excited due to the change of the moments of inertia even if the perturbation is small at the splitting. The damping timescale of the excited precession is widely ranged because of the uncertainty of the physical parameter of cometary nuclei. Another possibility for clarifying the evolution of the short period comets by studying the split cometary nuclei is also discussed. Author

**N93-19259*#** Tokyo Univ. (Japan). National Astronomical Observatory.
**METEOR RADIANT MAPPING WITH MU RADAR** **c89**
Jun-Ichi Watanabe, Tsuko Nakamura (Kyoto Univ., Japan ), T. Tsuda (Kyoto Univ., Japan ), M. Tsutsumi (Kyoto Univ., Japan ), A. Miyashita, and M. Yoshikawa (Ministry of Posts and Telecommunications, Tokyo, Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 625-627 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The radiant point mapping of meteor showers with the MU radar by using a modified mapping method originally proposed by Morton and Jones (1982) was carried out. The modification is that each meteor echo was weighted by using the beam pattern of the radar system. A preliminary result of the radiant point mapping of the Geminids meteor shower in 1989 is presented. Author

**N93-19260*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE COMET RENDEZVOUS ASTEROID FLYBY MISSION Status Report**
Paul Weissman and Marcia Neugebauer *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 629-632 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The Comet Rendezvous Asteroid Flyby (CRAF) mission was approved for a New Start by the United States Congress in 1989. CRAF will be developed in parallel with the Cassini (Saturn orbiter/Titan probe) mission. The two missions have been combined into a joint program because of the substantial cost savings (approximately $500 M, or greater than 25 percent) which can be realized by using a common spacecraft design, several identical science instruments, a single management team, and a joint ground operations and data handling system for the two missions. CRAF and Cassini will be the first users of the new Mariner Mark 2 spacecraft which has been designed to carry out the next generation of planetary missions to the outer planets and to small bodies. CRAF is a joint mission between the United States, Germany, and Italy. Each partner will provide both engineering hardware and science experiments. Cassini is a joint mission between the United States, Germany, Italy, and the European Space Agency (ESA), with ESA providing the Titan atmospheric entry probe, called Huygens. Author

**N93-19261*#** Smithsonian Astrophysical Observatory, Cambridge, MA.
**A NEW ACTIVITY INDEX FOR COMETS** **c89**
Fred L. Whipple *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 633-640 (For primary document see N93-19113 06-90)
(Grant NsG-7082)
Avail: CASI HC A02/MF A04

An activity index, AI, is derived from observational data to measure the increase of activity in magnitudes for comets when brightest near perihelion as compared to their inactive reflective brightness at great solar distances. Because the observational data are still instrumentally limited in the latter case and because many comets carry particulate clouds about them at great solar distances, the application of the activity index is still limited. A tentative application is made for the comets observed by Max Beyer over a period of nearly 40 years, providing a uniform magnitude system for the near-perihelion observations. In all, 32 determinations are made for long-period (L-P) comets and 15 for short-period (S-P). Although the correlations are scarcely definitive, the data suggest that the faintest comets are just as active as the brightest and that the S-P comets are almost as active as those with periods (P) exceeding 10(exp 4) years or those with orbital inclinations of i less than 120 deg. Comets in the range 10(exp 2) less than P less than 10(exp 4) yr. or with i greater than 120 deg appear to be somewhat more active than the others. There is no evidence to suggest aging among the L-P comets or to suggest other than a common nature for comets generally. Author

**N93-19262*#** Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
**THE MASS OF (1) CERES FROM PERTURBATIONS ON (348) MAY**
Gareth V. Williams *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 641-643 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The most promising ground-based technique for determining the mass of a minor planet is the observation of the perturbations it induces in the motion of another minor planet. This method requires careful observation of both minor planets over extended periods of time. The mass of (1) Ceres has been determined from the perturbations on (348) May, which made three close approaches to Ceres at intervals of 46 years between 1891 and 1984. The motion of May is clearly influenced by Ceres, and by using different test masses for Ceres, a search was made to determine the mass of Ceres that minimizes the residuals in the observations of May. Author

**N93-19263*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**GASPRA AND IDA IN FAMILIES**
James G. Williams *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 645-647 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The Galileo flyby candidates 951 Gaspra and 243 Ida are both in families. The former is in a complex of families associated with 8 Flora and the latter is in the Koronis family. The Flora and the Koronis families are described. The Galileo spacecraft will have the opportunity to sample fragments from two types of impacts; one impact totally destroyed the parent body and the other left a large body behind. The types of Ss are also different, the colors of Gaspra and the other Ss in the complex of families near 8 Flora are much redder in U-V than Ida and the Ss of the Koronis family. L.R.R.

**N93-19264*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**WHAT MAKES A FAMILY RELIABLE?**
James G. Williams *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 649-652 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Asteroid families are clusters of asteroids in proper element space which are thought to be fragments from former collisions. Studies of families promise to improve understanding of large collision events and a large event can open up the interior of a former parent body to view. While a variety of searches for families have found the same heavily populated families, and some searches have found the same families of lower population, there is much apparent disagreement between proposed families of lower population of different investigations. Indicators of reliability, factors compromising reliability, an illustration of the influence of different data samples, and a discussion of how several investigations perceived families in the same region of proper element space are given. Author

**N93-19265*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**THE UNUSUAL LIGHTCURVE OF 1990 TR**
Wieslaw Z. Wisniewski *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 653-656 (For primary document see N93-19113 06-90)
(Grant NAGw-716)
Avail: CASI HC A01/MF A04

Amor asteroid 1990 TR was monitored during three nights shortly after discovery. Obtained lightcurves did not reveal a repeatable curve with two maxima and two minima. However, some features suggest periodicity, and a synodic rotational period P = 6.25 hours was determined. Individual and composite lightcurves are presented. The colors are best represented by the class S. Author

**N93-19266*#** University of Southern California, Los Angeles. Space Sciences Center.
**VELOCITY DISTRIBUTIONS OF H AND OH PRODUCED THROUGH SOLAR PHOTODISSOCIATION OF H2O** **c92**
C. Y. Robert Wu, F. Z. Chen, and D. L. Judge *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 657-660 (For primary

document see N93-19113 06-90)
(Grants NAGw-1924; NSF ATM-87-22482; NSF DMR-88-21625)
Avail: CASI HC A01/MF A04

The calculated velocity distributions of atomic hydrogen and hydroxyl radicals produced through solar photodissociation of gaseous water molecules are presented. Under collisionless conditions, the calculation was carried out using the most recent available data for the production of H and OH through photodissociation of H2O from its dissociation onset throughout the EUV region. Because the lack of data in certain spectral regions, only upper and lower bounds to the velocity distributions can be obtained. The results show that the H atoms and OH radicals produced exhibit multiple velocity groups. Since most of the current cometary modeling uses a single velocity of 20 km/s associated with the photodissociation of H2O, the present results may be useful in interpreting the many peaks observed in the velocity distributions of cometary atomic hydrogen.

Author

**N93-19267*#** Westfield Coll., London (England). Astronomy Unit.
**FORMATION OF THE LEONID METEOR STREAM AND STORM**
Zidian Wu and I. P. Williams *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 661-665 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

It is well known that some meteor showers display a very high level of activity at certain times, the most famous being the Leonid shower with very spectacular displays at roughly 33 year intervals. This period being also the period of the parent comet of the stream, Comet Tempel-Tuttle. An investigation of the geometry of the comet and the Earth at the time of each high activity occurrence by Yeomans suggests that most of the meteoroids are found outside the cometary orbit and lagging the comet. The formation process of such a stream by numerically integrating the orbits of dust particles ejected from the comet and moving under the influence of gravity and radiation pressure are simulated. The intersection of these dust particles with the Earth is also considered and it is concluded that about 12 percent of the ejected particles may be observed and that of those observable, 63 percent will be outside the cometary orbit and behind the comet. Author

**N93-19268*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Albuquerque, NM.
**THE CONTRIBUTION OF ELECTRON COLLISIONS TO ROTATIONAL EXCITATIONS OF COMETARY WATER**
Xingfa Xie (Pennsylvania Univ., Philadelphia.) and Michael J. Mumma *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 667-670 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

The e-H2O collisional rate for exciting rotational transitions in cometary water is evaluated for conditions found in comet Halley during the Giotto spacecraft encounter. In the case of the O(sub 00) yields 1(sub 11) rotational transition, the e-H2O collisional rate exceeds that for excitation by neutral-neutral collisions at distances exceeding 3000 km from the cometary nucleus. Thus, the rotational temperature of the water molecule in the intermediate coma may be controlled by collisions with electrons rather than with neutral collisions, and the rotational temperature retrieved from high resolution infrared spectra of water in comet Halley may reflect electron temperatures rather than neutral gas temperature in the intermediate coma. Author

**N93-19269*#** Westfield Coll., London (England).
**ON THE DYNAMICAL STRUCTURE OF THE TROJAN GROUP OF ASTEROIDS**
R. V. Zagretdinov (Kazan State Univ., USSR ), I. P. Williams, and M. Yoshikawa (Tokyo Univ., Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 671-674 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Using a semi-analytical approach, domains of possible motion for Trojan asteroids were established. It is shown that stable librating motion is possible for both high inclination and high eccentricity. Frequency distributions were also produced for real Trojan asteroids, against differing libration amplitudes and libration periods. Author

**N93-19270*#** Osservatorio Astronomico, Turin (Italy).
**A COMPARISON BETWEEN FAMILIES OBTAINED FROM DIFFERENT PROPER ELEMENTS**
Vincenzo Zappala, Alberto Cellino, and Paolo Farinella (Pisa Univ., Italy ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 675-678 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Using the hierarchical method of family identification developed by Zappala et al., the results coming from the data set of proper elements computed by Williams (about 2100 numbered + about 1200 PLS 2 asteroids) and by Milani and Knezevic (5.7 version, about 4200 asteroids) are compared. Apart from some expected discrepancies due to the different data sets and/or low accuracy of proper elements computed in peculiar dynamical zones, a good agreement was found in several cases. It follows that these high reliability families represent a sample which can be considered independent on the methods used for their proper elements computation. Therefore, they should be considered as the best candidates for detailed physical studies. Author

**N93-19271*#** Polish Academy of Sciences, Warsaw. Space Research Centre.
**A CANDIDATE FOR THE PARENT BODY OF THE TAURID COMPLEX AND ITS SEARCH EPHEMERIS**
Krzysztof Ziolkowski *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 679-681 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

Untypical asteroid 5025 P-L, with its perihelion close to the orbit of Mercury and its aphelion between the orbits of Jupiter and Saturn, seems to be a good candidate for the parent body of the Taurid complex of small interplanetary objects. Evidence that this asteroid is a major source of meteoroids as well as an analysis of the orbits of asteroidal and cometary members of the Taurid complex, lead to the conclusion that 5025 P-L might be regarded as a remnant of a giant comet which was a progenitor of the overall complex according to the hypothesis of Clube and Napier. Unfortunately, the orbit of 5025 P-L is very poorly determined because the computations were based upon only three positional observations over an arc of only four days in October 1960. Any further research on the problem of origin and evolution of the Taurid complex needs better determined orbit of this key asteroid. Therefore its new positions are necessary. In order to enable the search of eventual trails of 5025 P-L on plates which can be found in archives, its ephemeris for the opposition in 1960, when the asteroid passed about 0.5 AU from the Earth, is presented. Author

**N93-19272*#** Max-Planck-Inst. fuer Kernphysik, Heidelberg (Germany).
**CoMA: A HIGH RESOLUTION TIME-OF-FLIGHT SECONDARY ION MASS SPECTROMETER (TOF-SIMS) FOR IN SITU ANALYSIS OF COMETARY MATTER**
Harry Zscheeg, J. Kissel, and G. Natour *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 683-686 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

A lot of clues concerning the origin of the solar system can be found by sending an exploring spacecraft to a rendezvous with a comet. The space experiment CoMA, which will measure the elemental, isotopic, and molecular composition of cometary dust grains is described. It will be flown on NASA's Comet Rendezvous Asteroid Flyby (CRAF) mission.

Author

**N93-19358#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CANONICAL FLOQUET PERTURBATION THEORY M.S. Thesis**
David J. Pohlen 15 Dec. 1992 161 p
(AD-A258970; AFIT/GA/ENY/92D-03) Avail: CASI HC A08/MF A02

Classical Floquet theory is examined in order to generate a canonical transformation to modal variables for periodic system. This transformation is considered canonical if the periodic matrix of eigenvectors is symplectic at the initial time. Approaches for symplectic normalization of the eigenvectors had to be examined for each of the different Poincare eigenvalue cases. Particular attention was required in the degenerate case, which depended on the solution of a generalized eigenvector. Transformation techniques to ensure real modal variables and real periodic eigenvectors

were also needed. Periodic trajectories in the restricted three-body case were then evaluated using the canonical Floquet solution. The system used for analyses is the Sun-Jupiter system. This system was especially useful since it contained two of the more difficult Poincare eigenvalue cases, the degenerate case and the imaginary eigenvalue case. The perturbation solution to the canonical modal variables was examined using both an expansion of the Hamiltonian and using a representation that was considered exact. Both methods compared quite well for small perturbations to the initial condition. As expected, the expansion solution failed first due to truncation after the third order term of the expansion. GRA

**N93-19513#** Lawrence Livermore National Lab., CA.
**RECENT PROGRESS ON ASTROPHYSICAL OPACITY**
F. J. Rogers and C. A. Iglesias Aug. 1992 9 p Presented at the International Conference on the Physics of Strongly Coupled Plasmas, Rochester, NY, 17-21 Aug. 1992
(Contract W-7405-eng-48)
(DE93-002892; UCRL-JC-111946; CONF-9208135-4) Avail: CASI HC A02/MF A01

Improvements in the calculation of the opacity of astrophysical plasmas has helped to resolve several long-standing puzzles in the modeling of variable stars. The most significant opacity enhancements over the Los Alamos Astrophysical Library (LAOL) are due to improvements in the equation of state and atomic physics. Comparison with experiment has corroborated the predicted large opacity increases due to transitions in M-shell iron. We give a summary of recent developments. DOE

**N93-19518#** Oulu Univ. (Finland). Dept. of Physics.
**FIFTH EISCAT SCIENTIFIC WORKSHOP: PROGRAMME AND ABSTRACTS Abstracts Only**
Asko Huuskonen, ed. 1991 80 p Workshop held in Saariselkae, Finland, 10-14 Jun. 1991; sponsored by Academy of Finland, Oulu Univ., and Sodankylae Geophysical Observatory
(Rept-120(1991); ISBN-951-42-3129-5; ETN-92-90673) Avail: CASI HC A05/MF A01

A survey on some major scientific results obtained during the ten years of EISCAT's operation, with reference to the original scientific observations of the radar is presented. The workshop abstracts are presented under the following session headings: ionosphere-magnetosphere interaction, aurora; E region; heating plasma and gyro lines; new facilities and techniques, theory; F region; mesosphere; stratosphere, thermosphere studies, D region; neutral winds and waves; coherent radar studies; polar cap; experiment design, data analysis; and poster presentations. For individual titles, see N93-19519 through N93-19589.

**N93-19519#** Oulu Univ. (Finland). Dept. of Physics.
**A CASE STUDY OF TWO AURORAL ARCS USING OPTICAL AND RADAR MEASUREMENTS Abstract Only**
Kari U. Kaila, Reijo Rasinkangas, Jyrki Manninen, and Tauno Turunen (Geophysical Observatory, Sodankyla, Finland ) *In its* Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Two auroral arcs were measured with optical instruments and EISCAT radar along the Tromso (Norway) field line on 16 Dec. 1990 at 16.35 UT. The radar integration time in this special experiment was 0.2 seconds for power profiles, and 3 seconds for the autocorrelation functions. The first arc is recorded only by radar because of clouds, but the second arc is measured also with a television camera and multichannel photometer. The radar measurements show clear differences between these arcs. Only the first arc has a strong northward, arc related electric field, and shows E region electron heating. The second arc has weak electric field and precipitation induced heating in the F region. The photometric data and electron density profiles show relatively soft precipitation. The latter weak auroral arc (intensity 15 kR in 557.7 nm) moved quickly across the photometer and radar beams. These measurements give information about the fine structure of the arc. ESA

**N93-19520#** Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics.
**PRECIPITATION ASSOCIATED ELECTRIC FIELD ENHANCEMENTS Abstract Only**
A. Aikio, Kari U. Kaila (Oulu Univ., Finland ), H. Opgenoorth (Swedish Inst. of Space Physics, Uppsala.), and Maths A. L. Persson (Swedish Inst. of Space Physics, Uppsala.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

EISCAT incoherent scatter radar and optical observations of an auroral arc on the premidnight sector are presented. The EISCAT measurement is a short scan between Tromso (Norway) and Kiruna (Sweden) south of the arc. A four channel photometer scans through the arc. Strong electric field enhancements south of the arc and optical intensification of the arc are seen simultaneously. The intensification of the arc is accompanied by its equatorward movement. Movement stops when the arc fades and a new arc appears in the orthogonal location. Processes giving rise to these observations are discussed. ESA

**N93-19521#** Technische Univ., Brunswick (Germany). Inst. fuer Geophysik und Meteorologie.
**OBSERVATIONAL EVIDENCE FOR FIELD-ALIGNED POTENTIAL DROPS AT VERY LOW ALTITUDES ASSOCIATED WITH TRAVELLING CONVECTION VORTICES Abstract Only** **c92**
H. Luehr, W. Blawert, and H. Todd (University of the South Pacific, Suva, Fiji ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

During Autumn 1984 and 1985, observational campaigns involving EISCAT and AMPTE were performed. EISCAT was operated in the special program United Kingdom polar measuring F region plasma parameters at high time resolution while AMPTE was probing the solar wind. Occasionally, bursts of rapid flows in the ionosphere were observed. With the help of ground magnetometers, most of the events could be identified as traveling convection vortices triggered by pressure variations in the solar wind. Data from the most prominent event occurring on 27 Oct. 1984 is presented. Data from a network of magnetometers is used to determine the movement of the current structure in the ionosphere. Subsequently, the temporal variations of the observed plasma drifts could be translated into a moving convection pattern. A striking result emerging was that the plasma flow (electric field) turned out to be much higher above the convection cell fed by the upward FAC than above the other cell, although the magnetic field recordings indicate equal current densities in both cells. The discrepancy strongly suggests that there was a potential drop along the upward Field Aligned Current even below 300 km (height of EISCAT observation). ESA

**N93-19522#** Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
**COMPARATIVE STUDY OF REGION 2 FIELD-ALIGNED CURRENTS AND CONVECTION ELECTRIC POTENTIAL AND IMPLICATIONS FOR THE DYNAMICS OF THE MAGNETOSPHERIC IONS Abstract Only**
Christophe Peymirat, Dominique Fontaine, and Catherine Senior *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Field aligned currents are due to pressure gradients created during the convection of the ionic component of the plasmasheet. The linear theory (i.e. linearizing the transport equations) predicts a phase quadrature between the convection electric potential and the field aligned current distributions (Blanc and Caudal, 1985). Statistical Kp dependent models of the field aligned currents inferred from the EISCAT radar (Fontaine et al, 1981) are used together with the electrostatic convection potential models derived from the same EISCAT data base by Senior et al (1990) to compute the phase difference between these two distributions. The resulting phase opposition is predicted by linear theory when including the effect of losses (Caudal, 1987; Peyrimat et al, 1991). ESA

**N93-19523#** Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
**STRUCTURE AND DYNAMICS OF FIELD-ALIGNED CURRENTS INFERRED FROM EISCAT DATA Abstract Only**
Dominique Fontaine, Christophe Peymirat, and Catherine Senior *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Common Program (CP) 3 experiments were analyzed from 1984 to 1987 to provide a statistical model of the distribution of field aligned currents from 61 to 72 degree invariant latitude. Statistics are first performed on horizontal currents computed from EISCAT measurements of electric fields and from a conductivity model. This conductivity model results from the combination of the model of solar produced conductivities statistically determined from the same data base by Senior et al (1991) and of the statistical model of conductivities due to particle precipitation (Hardy at al, 1987). The distribution of field aligned currents is computed from the divergence of height integrated horizontal currents. It is examined as a function of magnetic activity. ESA

**N93-19524#** EISCAT Scientific Association, Kiruna (Sweden).
**A COMPARISON STUDY OF THE IONOSPHERIC CONVECTION WITH MAGNETOSPHERIC PARTICLE MORPHOLOGY AND FIELD ALIGNED CURRENTS Abstract Only**
Asta Pellinen-Wannberg, L. Eliasson, and J. S. Murphree *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The high latitude ionospheric convection is one of the few global results that can be derived from EISCAT data. The convection reversals and Harang discontinuity give an idea about the magnetospheric particle population morphology and the location of field aligned currents. To study how relevant this connection is, convection results need to be compared with satellite data. This was done in one case study in connection with the Aureld VIP high rocket flight during Viking pass number 1408. In this case, the asymmetric convection measured by EISCAT fit very well with the particle population morphology, the field aligned currents and the auroral forms measured with different instruments on Viking. A continued study was initiated with all Viking magnetic midnight passes being at least under relatively disturbed conditions (Kp greater than or equal to 3+) while EISCAT was running a long scan program. There are about ten comparable cases to be studied. The preliminary results are reported. ESA

**N93-19525#** Swedish Inst. of Space Physics, Uppsala.
**OBSERVATIONS OF TOPSIDE IONOSPHERIC ION OUTFLOWS DURING AURORAL ACTIVITY: ARE THEY TURBULENCE INDUCED? Abstract Only**
J.-E. Wahlund, H. J. Opgenoorth, Maths A. L. Persson, I. Haeggstroem (Swedish Inst. of Space Physics, Kiruna.), E. V. Mishin (Academy of Sciences, USSR, Troitsk ), K. J. Winser (Royal Coll. of Surgeons, Dublin, Ireland ), and G. O. L. Jones (University Coll. of Wales, Aberystwyth.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

EISCAT observations (from UHF as well as VHF) of large field aligned bulk ion outflows from the topside ionosphere during auroral activity are presented. The ions (mainly O+) may reach field aligned ion fluxes of 2 x 10 exp 14/(sq. m)(s) which is a factor ten times larger than previously observed. In many cases, the flux is not constant within a magnetic flux tube. Two different types of ion outflows were identified. The first type is related to periods of strong perpendicular electric fields, enhanced ion temperatures, lifted F region (if existing), and low electron densities below 300 km, indicating a small amount of auroral precipitation. The second type is related to auroral arcs, enhanced electron temperatures, and occasional presence of ion acoustic turbulence. An extra ionization source within the F region seems also to be required from observations. Auroral arcs are also known from other observations than EISCAT to be characterized by upgoing field aligned currents, ion cyclotron wave activity, and ion conics down to an altitude of a few hundred km. The mechanism causing type 2 ion outflows is discussed. ESA

**N93-19526#** Oulu Univ. (Finland). Dept. of Physics.
**DETERMINATION OF E REGION EFFECTIVE RECOMBINATION COEFFICIENT USING IMPULSIVE PRECIPITATION EVENTS Abstract Only**
Tuomo Nygren, Kari U. Kaila, Asko Huuskonen, and Tauno Turunen (Geophysical Observatory, Sodankyla, Finland ) *In its* Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

A set of sudden increases followed by slow decay was observed in E region electron density on 17 Dec. 1990 using the EISCAT UHF radar. Simultaneous photometer observations indicate that the density enhancements are caused by impulsive particle precipitation with a very short duration, usually no more than 10 s. Effective recombination coefficient profiles in the E region are calculated from decaying electron densities using the ion continuity equation, and the results are compared with previous observations. The height resolution is about 1 km. Within the height interval 85 to 115 km, the recombination coefficient decreases approximately from 3.5 x 10 exp -13 to 2 x 10 exp -13 cu m/s. Theoretical recombination profiles for NO(+) and O2(+) ions are calculated using a model temperature profile. The measured profile lies close to the O2(+) curve, which seems to indicate that O2(+) is the main ion species in the E region. This result is in agreement with the theory which suggests that the O2(+) composition should increase shortly after a precipitation burst. It is pointed out that, due to a difference in ion composition, the effective recombination coefficient during short lived precipitation burst may be different from the steady state value. ESA

**N93-19527#** Geophysical Observatory, Sodankyla (Finland).
**NOCTURNAL HIGH LATITUDE E-REGION IN WINTER DURING EXTREMELY QUIET CONDITIONS Abstract Only**
Tauno Turunen, Tuomo Nygren (Oulu Univ., Finland ), and Asko Huuskonen (Oulu Univ., Finland ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

In Dec. 1990, a series of experiments was carried out using EISCAT UHF radar especially for studying ionospheric phenomena in the E region during very rapidly varying auroral conditions. In some nights, the magnetic activity was practically zero and no aurora was detected. An experiment designed to reveal rapidly varying ionospheric conditions is, however, an excellent experiment for monitoring slowly varying phenomena at very low density levels. Using integration times of a few minutes, reasonably accurate electron profiles well below the 10 exp 10 m(exp -3) level were obtained with spatial resolution of the order of 1 km. This kind of E layer cannot be seen by a standard ionosonde at all, and other methods are seldomly used for monitoring that kind of a layer, too. Behavior of extremely low density layers in quiet Winter nights is reported and many of the features are shown. Wave activity and narrow low density layers resembling sporadic E layers are seen almost continuously. Relative importance of the metallic ions and normal E layer ions in these extreme conditions is discussed. Some estimates for the ion production is given. Conductivities were reduced from the measured profiles. ESA

**N93-19528#** Grassmann (Volker), Wuppertal (Germany).
**AN INCOHERENT SCATTER EXPERIMENT FOR THE MEASUREMENT OF PARTICLE COLLISIONS Abstract Only**
Volker Grassmann *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The effect of particle collisions on incoherent scatter spectra depends on scatter altitude and radar frequency. For this reason, normalized incoherent scatter spectra obtained at very different radar frequencies are not identical, even when they have been measured at the same time in the same scatter volume. From a theoretical point of view this is valid for any nonzero collision frequency. Analyzing the spectral difference in a double frequency incoherent scatter experiment will improve the collision frequency resolution. The European Incoherent Scatter Association (EISCAT) which operates a UHF and VHF radar at the same location in Norway can perform simultaneous measurements on frequencies that differ by a factor of four, which is sufficient for the above mentioned purpose. ESA

**N93-19529#** EISCAT Scientific Association, Kiruna (Sweden).
**SPORADIC E LAYER FORMATION DURING THE GEMINID METEOR SHOWER Abstract Only**
Asta Pellinen-Wannberg, Gundmund Wannberg, and S. Kirkwood (Swedish Inst. of Space Physics, Kiruna.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Sporadic E layers are considered to consist of particles of meteoric origin. However, the correlation between these two phenomena has not been studied systematically with the incoherent scatter method. The most intensive and a well defined meteor shower, the Geminids, occurs every year around 12 to 15 Dec. A Barker coded alternating code program especially designed for this experiment was run to get the highest possible simultaneous spatial (450 m) and time resolution (2 s). This was the first time such modulation was applied in a real experiment. Hundreds of meteor tracks and several sporadic E layers were detected. The quantitative and preliminary qualitative results are reported. ESA

**N93-19530#** Southampton Univ. (England). Dept. of Physics.
**GRAVITY WAVES AND SPORADIC E LAYERS AS MEASURED BY EISCAT AND AIS Abstract Only**
B. S. Lanchester, Tuomo Nygren (Oulu Univ., Finland ), Asko Huukonen (Oulu Univ., Finland ), Tauno Turunen (Geophysical Observatory, Sodankyla, Finland ), M. J. Jarvis (British Antarctic Survey, Cambridge, England ), and Henry Rishbeth *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

During three days of quiet geomagnetic conditions in Aug. 1988, both the EISCAT UHF radar and the NOAA advanced ionosonde (Dynasonde) were operated from 12 to 22 UT. Sporadic E layers were observed on all three days, controlled by the action of the semidiurnal tide. Gravity wave activity was very evident in both data sets, and particularly visible in the changes of intensity and position of the layers. By combining the two data sets of measurements, it is possible to build up a spatial picture of the phase fronts passing over Tromso (Norway) with sporadic E layers acting as tracers for them in the E region. Structures in the electron density associated with gravity waves were observed to descend from the F region through the E region to merge with the increases in the layer intensity. The enhancements in the layers are ribbonlike and aligned along the gravity wave fronts in the east-west direction, traveling northwards at 60 km/h and about 30 km apart. ESA

**N93-19531#** EISCAT Scientific Association, Ramfjordbotn (Norway).
**INTRODUCTION TO IONOSPHERIC HEATING AT TROMSOE (NORWAY). PART 1: EXPERIMENTAL OVERVIEW Abstract Only**
M. T. Rietveld, H. Kohl (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ), and P. Stubbe (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

From Jan. 1993, the heating facility at Ramfjordmon (Norway) will be fully available to the EISCAT scientific community for experiments. A description of the technical capabilities of the facility and the broad range of geophysical and plasma physical experiments which are thereby made possible is given. An overview of the physical effects that a powerful HF electromagnetic wave incident on the ionosphere can produce on timescales ranging from tens of microseconds to minutes in height regions ranging from 20 to hundreds of km is presented. Emphasis is placed on the practical implementation of ionospheric heating experiments using the EISCAT radars as the main diagnostic, but other diagnostic techniques using ground based radars, radio links, receivers, photometers, and rocket and satellite instrumentation are described. ESA

**N93-19532#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).
**INTRODUCTION TO IONOSPHERIC HEATING AT TROMSOE (NORWAY). PART 2: CURRENT SCIENTIFIC PROBLEMS Abstract Only**
H. Kohl, M. Rietveld (EISCAT Scientific Association, Ramfjordbotn, Norway), and P. Stubbe *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

One of the main problems of ionospheric heating experiments that can be investigated using incoherent scattering radars is the excitation of 'parametric decay instabilities', where the heater produces high frequency (close to the heater frequency) and low frequency (ion acoustic) unstable waves. Observations are discussed in the light of this theory and unsolved problems are pointed out. Recently, the applicability of this kind of theory on ionospheric heating experiments was questioned. Instead, a strong Langmuir turbulence theory was developed. The differences and consequences are discussed. ESA

**N93-19533#** EISCAT Scientific Association, Ramfjordbotn (Norway).
**IONOSPHERIC CURRENTS: CAN THE INCOHERENT SCATTER PLASMA LINE SPECTRUM PROVIDE ROUTINE CURRENT MEASUREMENTS? Abstract Only**
A. P. vanEyken, U. P. Loevhaug, P. J. Christiansen (Sussex Univ., Brighton, England ), and P. J. S. Williams (University Coll. of Wales, Aberystwyth.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The measurement of the ion and electron components of the incoherent scatter spectrum can be made substantially routine under certain circumstances. However, the traditional interpretation of the resulting data sets in terms of ionospheric current flows leads to considerable problems of interpretation. Electron line techniques are reviewed, with particular reference to those which allow continuous observation of plasma parameters over extended time scales (many hours). Data sets obtained with the EISCAT UHF radar are presented and interpreted in terms of the underlying plasma physics. The implications for the routine exploitation of such methods are defined and some of the inherent limitations considered. ESA

**N93-19534#** Auroral Observatory, Tromso (Norway).
**THE POSSIBILITIES OF OBSERVING PLASMA AND GYRO LINES WITH THE EISCAT POLAR CAP RADAR Abstract Only**
N. Bjoernaa *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Numerical calculations are carried out to investigate the possibilities of observing plasma and gyro lines with the proposed EISCAT polar cap radar in Svalbard (Arctic). The dependence of these lines on ionospheric parameters and on the scattering geometry is discussed. ESA

**N93-19535#** Auroral Observatory, Tromso (Norway).
**ENHANCEMENT OF THE GYRO LINES BY SUPRATHERMAL PARTICLES Abstract Only**
E. Malnes and N. Bjoernaa *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The gyro lines are a pair of resonance lines in the power spectrum of incoherent scattering. They correspond to the electrostatic wavemode Omega(sub r) = + or - Omega(sub e)cos(theta) of a magnetized plasma where theta is the angle between the magnetic field and the scattering wave vector, and Omega(sub e) is the electron gyro frequency. The effects of suprathermal particles (precipitating electrons and protons, photoelectrons and secondary electrons) on the gyro lines are investigated. It is shown that the gyro lines can be enhanced if the velocity component of the suprathermal particles in the direction of the wave matches the phase velocity of the wave. The suprathermal particles are represented both by a shifted bi-Maxwellian, and by a power law velocity distribution. ESA

**N93-19536#** Auroral Observatory, Tromso (Norway).
**PHOTOELECTRON ENHANCED PLASMA-LINE INTENSITIES AT ANGLES WITH THE GEOMAGNETIC FIELD AS MEASURED BY EISCAT Abstract Only**
A. Fredriksen, N. Bjoernaa, and J. Lilensten (Grenoble-2 Univ., France ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Results from plasma line intensity measurements in Aug. 1990 with the EISCAT UHF radar at angles with the geomagnetic field lines are presented. In one experiment the antenna was pointed northwards at 73 degrees off the field line. At this angle, signals were detected with 30 min integration time at 3.75, 5 and 6.4 MHz, approximately 0.4 MHz below harmonics of the electron gyrofrequency. In another experiment, the antenna was pointed at angles from 0 to 50 degrees off the magnetic field in steps of 3 to 5 degrees. At offset frequencies between 6.0 and 6.75 MHz

plasma lines were readily detected with 10 min integration at angles up to 40 degrees off the field lines. Power measurements proved most reliable when the plasma line width was smaller but comparable to the filter bandwidth. The measured plasma line intensities were compared to theoretical intensities from full numerical calculations, based on a model of the Boltzman transport equation. ESA

**N93-19537#** Swedish Inst. of Space Physics, Kiruna.
**TRISTATIC OBSERVATIONS OF NATURAL PLASMA LINES WITH THE EISCAT UHF RADAR Abstract Only**
S. Kirkwood, N. Bjoernaa (Auroral Observatory, Tromso, Norway ), J.-E. Wahlund (Swedish Inst. of Space Physics, Uppsala.), and Maths A. L. Persson (Swedish Inst. of Space Physics, Uppsala.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

During 1990 and 1991 a number of special experiments were run incorporating plasma line measurements from all three EISCAT sites. The first successful remote site observations of photoelectron enhanced plasma lines were made in Aug. 1990 and of plasma lines associated with auroral arcs in Nov. 1990. The interpretation of these results in terms of extremely accurate electron densities, rather less accurate electron temperatures and rough approximations of field aligned currents are discussed. ESA

**N93-19538#** Massachusetts Inst. of Tech., Westford. Haystack Observatory.
**NEXT GENERATION INCOHERENT SCATTER RADARS Abstract Only** **c32**
J. M. Holt *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The 1990's promise to be an exciting time for users and practitioners of incoherent scatter radar as a new generation of radars is brought into operation at locations such as Svalbard, Resolute Bay, Alaska and Indonesia. Recent technological and theoretical advances make possible innovative new designs for antennas, transmitters, data acquisition systems, computers and communications systems. Some of the ideas and concepts currently under consideration are discussed, with particular emphasis on some results and lessons of recent data acquisition and analysis projects at the Millstone Hill radar. ESA

**N93-19539#** Cornell Univ., Ithaca, NY. National Astronomy and Ionosphere Center.
**NOTE ON THE SCATTERING OF ELECTROMAGNETIC WAVES FROM CHARGED DUST PARTICLES IN A PLASMA Abstract Only**
Tor Hagfors *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The application of the superposition of dressed particle concept to the problem of the electron density fluctuations in a plasma with embedded, charged dust grains is discussed. It is shown that the dressed particle approach breaks down when the dust grain separation r(sub d) and the charge Z become large, and that the scattering cross section then may be strongly enhanced. The criteria for the transition from one regime to the other are established and applied to the specific problem of scattering of electromagnetic waves from the polar mesopause. The calculations show that it is unlikely that the presence of dust grains, even when highly charged, can fully account for the observed enhanced polar mesospheric echoes. ESA

**N93-19540#** Tromsoe Univ. (Norway).
**THEORY OF RADAR SCATTERING FROM DUSTY PLASMAS Abstract Only** **c32**
Cesar LaHoz *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

A calculation of the scattering cross section of charged dust particles in a plasma is carried out for an incident electromagnetic wave with frequency much larger than the electron plasma frequency. The derivation employs the formalism embodied by the dressed test particle theorem of Hubbard and Rostoker. A critical discussion on the applicability of conventional plasma theory employed is given. It is shown that there is a range of values of the relevant parameters for which the underlying assumptions implied by the plasma approximation are applicable. The results depend crucially on neglecting the collective interactions of the dust particles with the plasma. This is justified when the number of dust particles in a Debye sphere is not large. The calculation is applied subsequently to the case of charged dust in the Earth's mesosphere in connection with polar mesospheric Summer echoes. Given efficient charging mechanisms of mesospheric dust, some features of charged dust scattering fit favorably with the observations, whereas others do not. At VHF radar frequencies the scattering cross section from a plasma with embedded charged dust particles depends strongly on the charge number of the dust particles. The enhancement of the dust scattering over the usual incoherent scattering due to ion acoustic thermal fluctuations can be several orders of magnitude, provided that the dust particles attain charges of several hundred. In addition, the scattering cross section decreases almost linearly as the radar frequency is increased. ESA

**N93-19541#** Geophysical Observatory, Sodankyla (Finland).
**FAST FOURIER TRANSFORM: A SOLUTION FOR DIGITAL SIGNAL PROCESSING IN INCOHERENT SCATTER EXPERIMENTS? Abstract Only** **c32**
Tauno Turunen *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The use of digital signal processing based on modulation methods which lead to a high demand for computing power was addressed. A possible way of using fast Fourier transform based computations in different incoherent scatter implications is described. It turns out that surprisingly few different algorithms are needed to solve the high computing power problem in a very general way. Standard FIR filters are not necessarily needed, but there are applications for them in phase coded experiments using pulse to pulse approach. ESA

**N93-19542#** EISCAT Scientific Association, Ramfjordbotn (Norway).
**SOLAR WIND VELOCITY MEASUREMENTS WITH THE EISCAT UHF ANTENNA ARRAY Abstract Only** **c92**
U. P. Loevhaug, William A. Coles (California Univ., San Diego.), R. Esser (Tromsoe Univ., Norway ), and J. Markkanen (EISCAT Scientific Association, Sodankylae, Finland ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The EISCAT UHF antenna array was used extensively during the Summer of 1990 to measure the solar wind velocity, between ten and one hundred solar radii from the surface, by observing the scintillation of cosmic radio sources. It was possible, for the first time, to select observations such that the same solar wind stream was measured simultaneously at several radial distances from the Sun. Since the solar wind is highly variable in latitude, longitude and time, this selection is crucial for the comparison of the observed speeds with those derived from solar wind expansion models. Half the observations agreed well with an MHD (Magnetohydrodynamic) model where a moderate amount of Alfven wave energy is added to the flow. A further quarter show low velocities inside twenty solar radii, but accelerate rapidly beyond. The remainder apparently accelerate close to the Sun and remain steady beyond twenty solar radii. Simple modifications to the MHD model itself, or to the boundary conditions, can match neither of the later two classes. The observations reported are the most accurate of their type. This is primarily due to the long baselines available between the three EISCAT antennas which allow time delay measurements between the receivers to be made very precisely. EISCAT scintillation observations will provide unique support for future spacecraft missions, such as the solar polar passage of Ulysses. ESA

**N93-19543#** Cornell Univ., Ithaca, NY. National Astronomy and Ionosphere Center.
**TWO-DIMENSIONAL CHIRP MAPPING OF DEEP, FLUCTUATING RADAR TARGETS Abstract Only** **c32**
Tor Hagfors (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany)

and E. D. Tereshchenko (Academy of Sciences, USSR, Murmansk) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

A procedure for the mapping of radar targets which are spread both in delay and frequency offset is described. The procedure is based on transmitted pulses with linearly chirped frequency variation. The reconstruction of the properties of the target scattering function is achieved by combining observations made with a large number of different chirp rates. The procedure is closely related to tomography methods employed in other observational contexts. The relationship between tomographic reconstruction and multiple chirp reconstruction is discussed. Possible applications of this reconstruction method exist in HF ionospheric modification experiments, in MST (Mesosphere, Stratosphere, Troposphere) radar applications as well as on the radar astronomy of planetary bodies. ESA

**N93-19544#** Centre de Recherches en Physique de l'Environnement, Saint Maur des Fosses (France).
**PROPOSAL FOR A COORDINATION BETWEEN EISCAT AND INTERBALL Abstract Only**
L. Girard *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The INTERBALL mission planned to be launched at the end of 1992, will consist of two pairs of satellites. Its present status is presented with particular emphasis on the auroral probe, the orbit of which should be well suited for coordinated observations with ground based instruments. Scientific aims to be achieved during the mission, which require the definition of some specifically designed modes to be operated with the EISCAT UHF/VHF system, are reviewed. Principles for the creation of an EISCAT/INTERBALL working group are discussed on the basis of what was successfully done during the previous EISCAT/VIKING coordination. ESA

**N93-19545#** Oulu Univ. (Finland). Dept. of Physics.
**MAIN IONOSPHERIC TROUGH: PRELIMINARY RESULTS FROM THE 1990 FINNISH-FRENCH EISCAT CAMPAIGN Abstract Only**
Reijo Rasinkangas, Tauno Turunen (Geophysical Observatory, Sodankyla, Finland ), G. Kremser, T. Boesinger, and Kari U. Kaila *In its* Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Results from field aligned radar and optical auroral measurements performed throughout the nights (that is, 15:00 to 06:00 UT) of 9 to 12 Dec. and 15 to 17 Dec. 1990 are presented. The overall magnetospheric activity was weak, especially during the first part of the campaign. Results in the electron densities of E and F regions are discussed. ESA

**N93-19546#** Grenoble-1 Univ. (France). Centre d'Etude des Phenomenes Aleatoires et Geophysiques.
**EISCAT MEASUREMENTS IN THE E AND F REGIONS DURING THE 12-16 FEBRUARY 1990 LTCS CAMPAIGN Abstract Only**
J. Lilensten, J. F. Gigot, W. Kofman, C. Lathuillere, and B. Pibaret *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The ionospheric behavior during the five day measurement period of the third international campaign of the Lower Thermospheric Coupling Study (LCTS) is shown. The magnetic conditions were quiet to very active, with Kp indices ranging from 0+ to 7-. Diurnal variations in the lower thermosphere, and a study of the answer to substorms of the ionosphere-thermosphere system, are presented. ESA

**N93-19547#** Grenoble-1 Univ. (France). Centre d'Etude des Phenomenes Aleatoires et Geophysiques.
**ION COMPOSITION IN THE AURORAL F REGION: COMPARISON OF EISCAT DATA AND IONOSPHERIC MODEL PREDICTIONS Abstract Only**
C. Lathuillere, J. J. Sojka (Utah State Univ., Logan.), and R. W. Schunk (Utah State Univ., Logan.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Statistical analysis was made on EISCAT ion composition data obtained from the CP0 (Common Program 0) and CP1 experiments performed between 1981 and 1986. The diurnal variation of the transition altitude between molecular and oxygen ions was found to be 26 km, which is much larger than the seasonal variation (8 km between Summer and Winter) and the magnetic activity variation (10 km for Kp ranging from 0 to 4). In addition, it was found that the extent of the transitioon region increases with the transition altitude. These results are compared with the TDIM model. The EISCAT Winter observations and the TDIM database were found to agree well for low magnetic activity and solar minimum conditions. Summer model and observations do not show the same agreement. Differences are discussed. In addition a comparison for different magnetic activity level, as given by Kp, is made, so as to separate electrodynamic effects and neutral atmosphere effects on the ion composition profile. ESA

**N93-19548#** Swedish Inst. of Space Physics, Uppsala.
**NUMERICAL CALCULATION ON IONOSPHERIC ELECTRON AND ION TEMPERATURES IN THE PRESENCE OF TURBULENCE Abstract Only**
F. R. E. Forme, J.-E. Wahlund, H. J. Opgenoorth, and Maths A. L. Persson *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

A numerical study of the effects of anomalous transport properties on the thermal structure of the topside ionosphere (250 km to 3000 km) for both ions and electrons was performed. In a plasma with a constant field aligned current density, current driven instabilities were introduced if their threshold conditions were fulfilled. The coupled electron and ion energy differential equations were solved both for the classical and the anomalous transport case. In a plasma which is stable to current driven instabilities turbulence may still be introduced for example by the interaction of an auroral mean with the ambient plasma. The energy equations were therefore solved for this case. Turbulence can result in a localized parallel enhanced electric field and a strong heating of the plasma, which in turn can produce ion outflows from the ionosphere. The first results of this numerical calculation are discussed. ESA

**N93-19549*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**PACE AND EISCAT RADAR OBSERVATIONS OF SHORT-LIVED FLOW BURSTS ON THE NIGHTSIDE Abstract Only**
M. P. Freeman (Imperial Coll. of Science and Technology, London, England), J. P. Morelli (Imperial Coll. of Science and Technology, London, England), S. W. H. Cowley (Imperial Coll. of Science and Technology, London, England ), M. Pinnock (British Antarctic Survey, Cambridge, England ), P. J. S. Williams (University Coll. of Wales, Aberystwyth.), and C. J. Farrugia *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Concurrent observations from two widely spaced radar experiments of quasi periodic flow bursts in the nightside are presented. The flow bursts closely resemble single radar observations reported by Williams et al. By using the Polar Anglo-American Conjugate Experiment (PACE) HF radar array at Halley Bay in conjunction with the EISCAT Common Program (CP) 2-D experiment, the flow bursts are shown to be a global phenomenon and important information as to their development and propagation can be determined. ESA

**N93-19550#** University Coll. of Wales, Aberystwyth. Dept. of Physics.
**PLASMA FLOW BURSTS IN THE AURORAL ZONE Abstract Only**
P. J. S. Williams, T. S. Virdi, R. V. Lewis, and M. Lester (Leicester Univ., England ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

EISCAT measurements of the night time ionosphere often show rapid variations in plasma velocity. These correspond to two different phenomena: a short lived flow burst which occurs simultaneously over several degrees of latitude and longitude; and a band of enhanced electric field, less than

20 km wide in the meridional direction, which drifts through the EISCAT field of view. In order to relate such enhancements of the electric field to the sequence of events in a substorm it is essential to distinguish between the two categories. With EISCAT this is best done using a rapid scanning program such as Common Program (CP) 2 or the United Kingdom special program FLUX. ESA

**N93-19551#** EISCAT Scientific Association, Ramfjordbotn (Norway).
**HIGH ALTITUDE MEASUREMENTS WITH THE EISCAT VHF RADAR AND THE DEVELOPMENT OF COMMON PROGRAMME SEVEN**
**Abstract Only**
U. P. Loevhaug, A. P. vanEyken, and Gudmund Wannberg (EISCAT Scientific Association, Kiruna, Sweden ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

EISCAT's VHF Common Program Seven (CP7) is being developed to make measurements at altitudes well above the range of the UHF Common Programs and it is hoped to produce reliable data above 1000 km. It is expected that this program will allow the polar wind to be studied routinely from the ground for the first time. The theory of the polar wind requires light ions, predominantly H+, to be accelerated upwards, with a transition from sub to supersonic flow, in an ionosphere dominated by O+ ions. Theoretical models suggest that the critical point (where the Mach number becomes equal to unity) can sometimes be as low as 1500 km. However, the relative abundance of high velocity H+ ions will always be very low and the routine derivation of H+ parameters consequently difficult. Data recorded during the development of CP7 is used to illustrate the special problems of this work and attention is directed towards some of the high altitude phenomena observed. ESA

**N93-19552#** Observatoire de Paris-Meudon (France). Dept. de Recherche Spatiale.
**NON MAXWELLIAN ION DISTRIBUTIONS IN THE AURORAL IONOSPHERE IN THE PRESENCE OF LARGE ELECTRIC FIELDS. PART 1: THE LOWER PART OF THE F REGION Abstract Only**
D. Hubert and E. Kinzelin *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The atomic O+ and molecular NO+ distributions of ions drifting in a realistic ionosphere composed of atomic O and molecular neutrals is discussed. The atomic O+ ion oxygen and molecular NO+ ion nitrogen temperature and temperature anisotropy throughout the F auroral region in the presence of large electric fields are studied. The O+ ion temperature is smaller than the NO+ ion temperature in the lower part of the F region, and this effect increases with the increasing of the neutral temperature as well as the ion-neutral drift velocity. The O+ ion temperature anisotropy is maximum around 290 km in altitude for a constant neutral temperature as well as a constant ion-neutral drift velocity throughout the F region. For similar conditions the NO+ ion temperature anisotropy is constant between 175 km and 250 km in altitude, and decreases for higher altitudes. The properties of the line of sight ion distributions are displayed. The O+ distribution shows two different shapes. The fitting of these distributions by a one dimensional toroidal distribution is discussed. ESA

**N93-19553#** Observatoire de Paris-Meudon (France). Dept. de Recherche Spatiale.
**NON MAXWELLIAN ION DISTRIBUTIONS IN THE AURORAL IONOSPHERE IN THE PRESENCE OF LARGE ELECTRIC FIELDS. PART 2: THE UPPER PART OF THE F REGION Abstract Only**
E. Kinzelin and D. Hubert *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The influence of O+ - O+ and O+ - O collisions on the distribution function of O+ ions is investigated by using a modified relaxation model. The nonequilibrium distribution function is a linear combination of a Maxwellian term and a toroidal one. The coefficient of the former depends on the ion-ion collision frequency nu(sub ii) although the coefficient of the latter is a function of ion-neutral collision frequency nu(sub in). Those frequencies are obtained self consistently with the model taking into account the non Maxwellian state of the plasma. The present study predicts that the nu(sub ii)/nu(sub in) ratio is greater than in the case of a Maxwellian steady state. It yields a distribution function at 500 km in altitude close to a local Maxwellian state for typical values of the electric field. The model also suggests that the conditions for the occurrence of ion-cyclotron instability and an electrostatic one are more drastic than it was expected so far. The properties of a semiphenomenological model in the presence of a realistic ionosphere composed of atomic oxygen and molecular nitrogen neutral is discussed. ESA

**N93-19554#** Observatoire de Paris-Meudon (France). Dept. de Recherche Spatiale.
**NON MAXWELLIAN ION DISTRIBUTIONS IN THE AURORAL IONOSPHERE IN THE PRESENCE OF LARGE ELECTRIC FIELDS. PART 3: THE MEASUREMENT PROBLEMS WITH A RADAR Abstract Only**
D. Hubert, E. Kinzelin, and C. Lathuillere (Grenoble-1 Univ., France ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The three dimensional Raman distribution as a model for fitting non-Maxwellian distributions is revisited. The three dimensional Raman's model is demonstrated as unable to quantitatively predict the Post-Rosenbluth or ion cyclotron instability threshold. The application of this model to deduce ion temperature anisotropy from only one radar spectra measurement is shown to be restricted to specific aspect angles and small electric field intensities. This model provides the line of sight temperature and then the thermodynamical temperature for aspect angle equal to 54.7 degrees. A strategy to measure the plasma parameters in nonequilibrium state is discussed. It is based on new properties of the non-Maxwellian distribution functions. The possibility of measuring the microscopic state of the ionospheric plasma in terms of distribution functions from three different line of sight spectra is shown. ESA

**N93-19555#** EISCAT Scientific Association, Kiruna (Sweden).
**RESEARCH OF THE POLAR MIDDLE AND LOWER ATMOSPHERE WITH AN MST RADAR ON SPITSBERGEN (SVALBARD, ARCTIC) Abstract Only** **c46**
Juergen Roettger *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Research directions to studying the Arctic Mesosphere Stratosphere and Troposphere (MST) with radar are described. These are effects of Joule heating and high energy particle precipitation on the mesosphere. Possible influences in the dynamics and chemistry of the middle atmosphere are pointed out. The stratospheric fine structure, as seen by radar, is discussed and similarities to ozone layer structures indicated. Vertical transport, the structure and dynamics of tropopause folding, polar stratospheric clouds, gravity wave breaking and momentum deposition as well as turbulence, investigated by radar, are discussed. Certain tropospheric phenomena, such as polar lows, can also be studied by an MST radar. Instrumental specifications, which should be fulfilled for a polar MST radar and which would not add substantial costs to the total investment, are outlined. ESA

**N93-19556#** Geophysical Observatory, Sodankyla (Finland).
**POLAR CAP ABSORPTION EVENTS OBSERVED DURING THE EISCAT OPERATION IN 1981-1989 Abstract Only** **c92**
Hilkka Ranta and Aarne Ranta *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

During the years 1981-1989 a total of 71 solar proton events were observed. Polar Cap Absorption (PCA) events are an ionospheric signature of the precipitation of energetic protons into the Earth's atmosphere. The protons penetrate into the mesosphere causing enhanced D region electron densities. Dividing the events into strong, pfu greater than 1000 (where pfu is the proton flux measured at geosynchronous satellite orbit in units of ((cu cm ssr) to the -1 power), medium pfu greater than 100 and less than 1000, and weak events pfu less than 100, only strong and medium events have a considerable effect in the lower ionosphere. During the

strong events the mean daily absorption at 30 MHz measured in the auroral zone is greater than 2 dB, during the medium events less than 2 dB and during weak events less than 1 dB. The most active year during the EISCAT operation was 1989 when 23 solar proton events were observed including 6 strong events. Variation of the electron density in the D region during PCA events is discussed. ESA

**N93-19557#** Geophysical Observatory, Sodankyla (Finland).
**EISCAT INCOHERENT SCATTER RADAR OBSERVATIONS AND MODEL STUDIES ON DAY TO NIGHT VARIATIONS IN THE IONOSPHERIC D-REGION DURING THE PCA EVENT OF AUGUST 1989 Abstract Only**
Esa Turunen *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p Previously announced as N92-10559 (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

An intense solar proton event causing enhanced ionization in ionospheric D region occurred on 12 Aug., 1989. The event was partially observed during three successive nights by the EISCAT incoherent scatter radar at Ramfjormon near Tromso (Norway). Ion production rate calculation for GOES-7 satellite measurements of proton flux and a detailed steady state ion chemistry model of the D region are used together with the raw radar data to deduce the time variations of the electron concentration, negative ion to electron density ratio, neutral temperature and mean ion mass. The quantitative interpretation of EISCAT data as physical parameters and the solar radiation control of the deduced time variation are discussed. The deduced temperature variations are compared with simultaneous temperature measurements at Andoya (Norway) based on lidar technique. ESA

**N93-19558#** EISCAT Scientific Association, Kiruna (Sweden).
**INITIAL RESULTS FROM THE LOW ALTITUDE EXPERIMENTS CP-6 AND UP-1 Abstract Only**
P. N. Collis and M. T. Rietveld (EISCAT Scientific Association, Ramfjordbotn, Norway ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Measurements of the lowest part of the ionosphere using the EISCAT VHF system are provided by Common Program (CP)-6, which was introduced in 1990. Spectral width, Doppler shift and electron density are obtained with a resolution of 1.05 km, from 70 km altitude up to about 95 km altitude, using a vertically directed antenna. Approximately 250 hours of observations have been obtained to date, often simultaneously with UHF CP operation. Experiment UP-1 uses the same pulse scheme as CP-6 and is intended for operation at short notice during Polar Cap Absorption (PCA) events. Antenna pointing is selected by the experimenter, depending on the lowest altitude required for the observations. Spectra have been measured from altitude required for the observations. Versions of UP-1 exist for both the VHF and UHF radars. Six separate PCA events have been monitored by UP-1 since early 1988, in a total of more than 100 hours of observations. UHF measurements were obtained during all these events but VHF cooperation was only possible for one of them. Initial results from these experiment schemes, relating to atmospheric dynamics and ion chemistry, are presented. ESA

**N93-19559#** Norwegian Defence Research Establishment, Kjeller.
**D-REGION INCOHERENT SCATTER SPECTRA: DISCREPANCIES BETWEEN OBSERVATIONS AND CURRENT THEORY Abstract Only**
Ulf-Peter Hoppe, Georg Hansen, Esa Turunen (Geophysical Observatory, Sodankyla, Finland ), and Paivio Pollari (Oulu Univ., Finland ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Extended D region observations were performed with the EISCAT UHF radar during the Aug. 1989 PCA (Polar Cap Absorption) event. The excellent quality of this data, together with temperature measurements by lidar about 130 km from Tromso (Norway) makes it possible to compare the observed incoherent scatter spectra with current theory. The discrepancy found, (also in data collected before the PCA event), leads to examination of other published observed D region spectral measurements. In the absence of temperature or density observations together with these earlier measurements, the new CIRA 86 model is used. The spectra of incoherent scatter from the D region are generally found to be narrower than current theory predicts, independent of radar frequency, latitude, or season. Some possible reasons for this discrepancy are discussed. ESA

**N93-19560#** Geophysical Observatory, Sodankyla (Finland).
**INTERPRETATION OF INCOHERENT SCATTER SPECTRAL WIDTH CHANGES IN THE D-REGION DURING AN AURORAL PRECIPITATION EVENT Abstract Only**
Esa Turunen *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Auroral high energy electron precipitation, which causes excess ionization also in the D region heights, gives condition of high signal to noise ratio in incoherent scatter radar measurements of the lowest ionosphere and makes it possible to get reliable measurements of scattered spectral width. However the interpretation of the spectral width may not be straightforward. During auroral precipitation events recorded by the EISCAT VHF radar on 17 Apr. 1987 between 19.05 and 20.30 UT, large variations in the spectral width were detected. The nearby 32 MHz riometer in Ramfjordmoen (Norway) recorded 1.5 dB maximum absorption during the precipitation. The possible interpretations of the observed variations are discussed. ESA

**N93-19561#** EISCAT Scientific Association, Kiruna (Sweden).
**POSSIBLE CAUSE AND CONSEQUENCE OF LAMINATED POLAR MESOSPHERE SUMMER ECHOES Abstract Only**
Juergen Roettger *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Polar Mesosphere Summer Echoes (PMSE) observed with the EISCAT VHF radar as well as other high (and middle) latitude MST (Mesosphere, Troposhere, Stratosphere) radars often show thin layering of structures, which sometimes can be quasiperiodic in altitude. Typical examples of these echo structures, called laminated PMSE, are presented. The enhanced scatter cross section of PMSE is very likely related to the low temperatures occurring near the high altitude mesopause in Summer. Long period waves, which can be steepened, are proposed to periodically modulate the temperature profile. In the wave phases with low temperature, the scatter cross sections will be enhanced locally giving rise to laminated PMSE. These laminated structures, originating from atmospheric waves move downward with the phase velocity of these waves. The downward progressing laminae are often thinner than the range resolution of radars. The mean vertical velocity, measured during PMSE conditions, will then be affected by the vertical phase velocity of waves and, thus, does not reflect the real fluid velocity. This effect can explain the unsettled question as to why polar MST radars measure a substantial downward velocity instead of an upward velocity, which is reasonably expected from the existence of the cold polar mesopause in Summer as well as from model computations. ESA

**N93-19562#** Oulu Univ. (Finland). Dept. of Physics.
**DETERMINATION OF D-REGION PLASMA VELOCITY VECTOR FROM SCANNING GEN-11 DATA Abstract Only**
Paivio Pollari *In its* Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The Polar Mesosphere Summer Echoes (PMSE) campaigns of the last two summers have provided a lot of data where the D region has been measured using a monostatic three position scan. During the good signal to noise ratio this gives (among other information) three independent components of plasma velocity as a function of time. The determination of plasma velocity vector was examined by using spline interpolation in height and altitude for each measured velocity component. Velocity vector is then obtained using the beam swing approach. The reliability check of the results is based on using error bars of fitted results as weights in spline interpolation. The effect of different postintegration times is also discussed. ESA

**N93-19563#** Grenoble-1 Univ. (France). Centre d'Etude des Phenomenes Aleatoires et Geophysiques.

**EISCAT-MICADO COORDINATED MEASUREMENTS OF MERIDIONAL NEUTRAL WINDS AND TEMPERATURES IN THE F REGION Abstract Only** **c46**

C. Lathuillere, G. Thuillier (Centre National de la Recherche Scientifique, Verrieres-Le Buisson, France ), J. Lilensten, D. Hubert (Observatoire de Paris-Meudon, France ), M. Herse (Centre National de la Recherche Scientifique, Verrieres-Le Buisson, France ), and V. Fauliot (Centre National de la Recherche Scientifique, Verrieres-Le Buisson, France ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)

Avail: CASI HC A01/MF A01

During the French campaign of Feb. 1989, coordinated measurements were performed with EISCAT and the MICADO interferometer using the red line emission. A comparative study of meridional neutral winds for the night of 8-9 Feb., as well as a study of the ion energy balance during a Joule heating event taking into account the ion temperature anisotropy measured by the three EISCAT sites, are shown. It is shown that it is possible to deduce the ion composition in a period of high electric field. ESA

**N93-19564#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).

**DYNAMICS OF THE AURORAL IONOSPHERE DEDUCED FROM EISCAT CP1 OBSERVATIONS Abstract Only**

Klaus Rinnert *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)

Avail: CASI HC A01/MF A01

The dynamical coupling of the moderately disturbed auroral E region with the upper ionosphere and neutral atmosphere is demonstrated on the basis of CP1 (Common Program 1) measurements during the evening hours of 25 Mar. 1986. Model calculations are presented to describe the time variations of electron and ion temperatures. The special event under discussion seems to reflect conditions in the source region of a TID (Traveling Ionospheric Disturbance). ESA

**N93-19565#** Ministry of Posts and Telecommunications, Tokyo (Japan). Communications Research Lab.

**THE NEUTRAL WIND IN THE E-REGION FROM CP-1 DATA Abstract Only**

Manabu Kunitake and Kristian Schlegel (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)

Avail: CASI HC A01/MF A01

The neutral wind velocities at three different altitude levels (101/102, 109/110 and 117/120 km) in the E region were computed from CP1 (Common Program 1) data of the years 1984-1990. The fundamental characteristics of the neutral wind velocity variations, namely, semidiurnal and diurnal variation and the mean wind were estimated by a least squares fit. They are discussed as a function of season and altitude. Comparison with theoretical models as well as with other experimental results from incoherent scatter radars, MF radars, and meteor radars were made. Some magnetospheric influences in the neutral wind were investigated. ESA

**N93-19566#** University Coll. of Wales, Aberystwyth. Dept. of Physics.

**ALTITUDE VARIATIONS IN AMPLITUDE AND PHASE OF TIDAL OSCILLATIONS AT HIGH LATITUDE Abstract Only**

T. S. Virdi and P. J. S. Williams *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)

Avail: CASI HC A01/MF A01

In previous works on EISCAT observations of tidal oscillations, Common Program 1 (CP1) data, where the method of determining tides was based on tristatic measurements of plasma velocities, provided only a limited measure of altitude variations in amplitude and phase oscillations, as the data were only available at four altitudes in the E region. Common Program 2 (CP2), using the monostatic method provides velocity data at every 2.7 km between 100 and 130 km. CP2 data are used to determine the variations of tidal amplitude and phase with altitude, using the improved height resolution. Day to day variations in amplitude and phase are studied. The results are discussed in light of the previous works. ESA

**N93-19567#** Graz Univ. (Austria). Inst. fuer Meteorologie und Geophysik.

**THE IONOSPHERIC RESPONSE TO ATMOSPHERIC GRAVITY WAVES IN THE EISCAT REGION Abstract Only**

G. Kirchengast, R. Leitinger, and Kristian Schlegel (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)

Avail: CASI HC A01/MF A01

The equations of continuity and momentum for the electrons were used to construct a numerical model particularly adequate for the F layer of the high latitude ionosphere. It yields the spatial temporal evolution of the plasma parameters 'electron density' and 'magnetic field parallel ion velocity'. The main properties and capabilities of the model at the present stage of development and results of the simulation of the response of the high latitude ionosphere to model large scale atmospheric gravity waves, which are overlaid upon the neutral atmosphere as disturbances, are presented. This is done in the presence of varying background neutral winds and electric fields. Several important features of the observed ionospheric signatures are discussed. Future aims are addressed, and (maybe) first results of comparison with genuine EISCAT data are presented. ESA

**N93-19568#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).

**NONLINEAR INTERACTIONS ASSOCIATED WITH TID'S IN THE QUIET POLAR F-REGION FROM EISCAT OBSERVATIONS Abstract Only** **c46**

Shuying Ma and Kristian Schlegel *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)

Avail: CASI HC A01/MF A01

Observational evidences of nonlinear wave-wave interactions associated with TID's (Traveling Ionospheric Disturbances) in the quiet day time polar F region are acquired from EISCAT CP1 (Common Program 1) measurements. The dynamic frequency spectra in the upper F region and the one dimensional wave number spectra of TID's show an energy cascading from longer periods (larger scales) to shorter ones (smaller scales). The bispectra and the change rates of the action density suggest that a chain of resonant triple interactions take place. The observed nonlinear interactions are generally associated with unusually large gradients of the background ion temperatures and a change of the direction of the field aligned mean neutral wind. The TID including gravity wave wavenumbers along the magnetic field k(sub xi) are calculated by a newly developed inverse method suitable for the upper F region with a negligible perpendicular electric field. The k(sub xi) obtained as a function of period and altitude covering altitudes from 256 km to 587 km show a decrease with height and a nearly nondispersive character at greater heights. The nonlinear processes in the higher F region are accompanied by a turn of k(sub xi) around zero which indicates reflections. The weakness of the dispersion together with the reflections seem to enable the reasonable selection conditions. In addition, the lower F region containing a temperature discontinuity is another main area for nonlinear processes, where more dramatic and complicated nonlinear evolutions of TID spectra are observed. ESA

**N93-19569#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).

**VERTICAL STRUCTURE OF AGW ASSOCIATED IONOSPHERIC FLUCTUATIONS OBSERVED WITH EISCAT Abstract Only**

Takashi Shibata and Kristian Schlegel *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)

Avail: CASI HC A01/MF A01

A vertical structure of AGW (Atmospheric Gravity Wave) associated fluctuation of ionospheric plasma parameters for the 100 to 240 km altitude range was investigated by making use of the data provided from the Tromso (Norway) measurements in the EISCAT CP1 (Common Program 1) mode. The dominant fluctuation period and the distribution of line of sight

wavenumber (k(sub parallel)) were investigated over a period range of 20 to 300 min and a wavenumber range of -0.1 to 0.1 km(exp -1) with the aid of a space time spectrum analysis. By means of band pass filtering with various frequencies, fluctuation structures were further investigated in the time altitude section. In order to avoid a contamination of electrodynamical effects e.g., by electric field and particle precipitation in the detection of AGW activity, the present analyses were restricted to data taken during relatively low geomagnetic activity. For the majority of the cases, two wavenumber regions occupied by the dominant components of the upgoing and downcoming AGW's were found to be not symmetric. The region corresponding to a downcoming AGW is slightly extended to high-(absolute value of k(sub parallel)) values compared to the upgoing one. This asymmetry can be explained in terms of the southward tilt of the radar beam on the Tromso measurements. Through the analysis of fluctuation structures in the time altitude section, a clear downcoming AGW was identified simultaneously with its upgoing counterpart. The magnitude of the line of sight phase velocity of the former was observed to be much smaller than that of the latter. This agreed well with the statistical features deduced from the space time spectrum analyses. Some parts of the downcoming AGW spectrum might be interpreted in terms of the reflection of upgoing waves from the wind shear. ESA

**N93-19570#** Southampton Univ. (England). Dept. of Physics.
**INDI Abstract Only**
C. J. Davis, A. D. Farmer (Rutherford Appleton Lab., Chilton, England ), and A. Aruliah (University Coll., London, England ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The INDI experiment makes measurements in several positions at heights of 240 km, while the Fabry-Perot interferometer at Kiruna (Sweden) runs simultaneously. These data can then be used to examine the interaction of the F region plasma with the thermosphere. In particular a comparison may be possible of the relative importance of the terms in the neutral wind momentum equation. ESA

**N93-19571#** Toulon Univ. (France). Lab. de Sondages Electromagnetiques de l'Environnement.
**HF RADAR OBSERVATIONS OF TEMPORAL VARIATIONS IN THE HIGH LATITUDE CONVECTION Abstract Only**
C. Hanuise, J. P. Villain (Centre National de la Recherche Scientifique, Orleans, France ), C. Senior (Centre de Recherches en Physique de l'Environnement, Saint Maur des Fosses, France ), J. C. Cerisier (Centre de Recherches en Physique de l'Environnement, Saint Maur des Fosses, France ), R. A. Greenwald (Johns Hopkins Univ., Laurel, MD.), and K. B. Baker (Johns Hopkins Univ., Laurel, MD.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Coherent HF radars are presently in operation at Goose Bay and Schefferville (Canada) to study the convection in the high latitude ionosphere. From the line of sight components of the plasma velocity measured by beach radar over a common field of view nearly instantaneous maps of the two dimensional plasma flow are obtained over the auroral zone and the polar cap. These maps have a time resolution of a few minutes. They drift in MLT with the Earth rotation. From a time series of such convection maps, the variation with universal time (UT) of the latitudinal velocity profile at a fixed MLT are obtained. These represent 'true' UT time variations of the convection. Examples of such variations are shown. ESA

**N93-19572#** Finnish Meteorological Inst., Helsinki.
**STARE: A NEW COHERENT RADAR IN SCANDINAVIA Abstract Only** **c32**
P. Janhunen, R. Pellinen, W. Schmidt, and J. Silen *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Transmitter replacement and radar theory improvement have lead to the decision to upgrade the STARE (Scandinavian Twin Auroral Radar Experiment) stations in Finland and Norway, thereby improving the system's spatial and time resolution and the reliability and amount of information. The modified radar with a new transmitter, experiment control and data processing facilities and an upgraded receiving system started its operation in the Spring of 1991. The new design allows time resolution down to 1 sec and spatial resolution down to 7.5 km. Experiments can be optimized for special purposes. The standard data contain power profiles and multipulse autocorrelation functions, from which velocities and spectra can be calculated. Examples from recent measurements are shown. For ionospheric electrodynamics studies the STARE data is supported by IMAGE (International Monitor for Auroral Geomagnetic Effects) two dimensional magnetometer network data and auroral images obtained by all sky cameras operated in or near the STARE field of view. A dedicated work station with appropriate software to integrate the various original data and to simulate conductivity profiles obtained from the optical information is under development. All these activities are focusing on effective operation during the forthcoming Freja, Interball and ISTP missions. ESA

**N93-19573#** Rutherford High Energy Lab., Chilton (England).
**THE COSCAT EXPERIMENT: EISCAT OBSERVATIONS OF COHERENT SCATTER AT SMALL ASPECT ANGLES Abstract Only** **c32**
I. W. McCrea, K. Schlegel (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ), Tuomo Nygren (Oulu Univ., Finland ), T. R. Robinson (Leicester Univ., England), M. Lester (Leicester Univ., England), and T. B. Jones (Leicester Univ., England) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

With the 500 W COSCAT transmitter, a program of passive observations were undertaken with the aims: to find the optimum observing direction for the detection of backscatter; and to obtain a statistical dataset of spectral moments such as backscatter power, Doppler velocity, and spectral width. Results are presented from four observing campaigns and compared with previous coherent scatter observations. A new finding was that the most narrow spectra appear to be associated with phase speeds of order 420 ms(exp -1), in accordance with recent theoretical predictions for irregularities stabilized by anomalous collisions. The most recent passive observations are performed with increased spectral resolution to detect detailed structure in the coherent scatter spectra. The initial coordinated coherent and incoherent scatter observations attempted to make simultaneous measurements of E region irregularities and F region plasma flows on the same magnetic field line. Some preliminary analysis of the recent data are presented and the results discussed. ESA

**N93-19574#** Auroral Observatory, Tromso (Norway).
**THE EISCAT SVALBARD (ARCTIC) RADAR Abstract Only** **c32**
N. Bjoernaa, B. Hultqvist (Swedish Inst. of Space Physics, Kiruna.), W. Kofman (Grenoble-1 Univ., France ), J. Roettger (EISCAT Scientific Association, Kiruna, Sweden ), K. Schlegel (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, Germany ), E. Turunen (Geophysical Observatory, Sodankyla, Finland ), and D. M. Willis (Rutherford Appleton Lab., Chilton, England ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

The EISCAT scientific association put forward a proposal for the establishment of a new ionospheric and atmospheric scatter radar near Longyearbyen on Svalbard (Arctic). A report on the design specification was prepared by the EISCAT polar cap radar working group. An outline of the report is presented. ESA

**N93-19575#** Academy of Sciences (USSR), Murmansk. Polar Geophysical Inst.
**ELECTRIC FIELDS AND CURRENTS IN THE CUSP REGION AS A RESULT OF DIFFUSION EFFECTS ON THE MAGNETOPAUSE Abstract Only**
V. G. Pivovarov *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Generation of the electric field and currents in the cusp region of the Earth's magnetosphere is an important problem of magnetospheric physics. A diffusion process on the magnetopause is a relevant model responsible for such generation. With the suggestion that the plasma flow in the diffusion layer has a slight feedback influence from the ionosphere, there

is a solution for the electric field potential distribution into and in a vicinity of the dayside cusp. The model allows the ionospheric current flow to be built for different IMF (Interplanetary Magnetic Field) parameters as well as quantitative comparison of the model with experimental data to be made. A relevant agreement of the mentioned model experiment comparison suggests that the diffusion model under consideration can be a realistic part of the magnetospheric electrodynamics and that the diffusion process has an important role in the boundary layer formation. ESA

**N93-19576#** Helsinki Univ. of Technology, Espoo (Finland). Dept. of Theoretical Physics.
**A GENERAL EXPERIMENT DEFINITION SYSTEM AND ITS APPLICATIONS Abstract Only** **c32**
Markku S. Lehtinen *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

An investigation that attempts to find the common features behind all different types of incoherent scatter measurements, so that it becomes possible to describe the most general incoherent scatter measurement using a single, well defined set of variables, is presented. The system presently makes use of the GUISDAP analysis package. The general experiment design parameters make it possible to further develop the system as an experiment design tool for defining the pulse form and signal processing algorithms that are used in actual experiments. The use of statistical inversion theory guarantees the use of optimal analysis methods. To be general enough, the experiment description parameters must provide all the information necessary for statistical inversion methods. At the same time it is possible to build an experiment evaluation system where the behavior of different experiments can be analyzed and/or simulated in the design phase. How this is accomplished is discussed, as well as further plans for experiment design. Fully developed, the system will integrate together many of the tasks presently performed by the various languages (like TLAN, ELAN, and CLAN) in EISCAT. Because of the integrated analysis and experiment evaluation capabilities, and because of easy portability to different computers, it is felt that there is a great deal of promise for making incoherent scatter experiment design, running, and analysis more straightforward. ESA

**N93-19577#** EISCAT Scientific Association, Kiruna (Sweden).
**THE G2-SYSTEM, A SECOND GENERATION EXPERIMENTAL PHILOSOPHY FOR EISCAT Abstract Only** **c32**
Gudmund Wannberg *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

In recent years, changing requirements and new developments in coding techniques have created a demand for the use of complementary and alternating codes in EISCAT experiments and for the possibility of mixing these with more conventional modulations. The original signal processing and experiment control hardware was unable to cope with this demand, so several major hardware upgrades (e.g. decoder for alternating codes, data loading channel for the buffer memory) were designed and integrated into the system over the period 1988-1991. As the GEN-SYSTEM tools can only address the pre-1988 hardware, new software was developed and existing system software was enhanced to make the new hardware devices fully accessible from user programs. This upgrading program is now completed at all EISCAT sites. To make optimum use of the new tools, certain experiment design rules should be followed. These can be regarded as a superset of the GEN-SYSTEM and have been named the G2-SYSTEM. A program library containing alternating code analogs to most GEN-SYSTEM experiments is being developed. An overview of the G2-SYSTEM tools is given and G2-SYSTEM analogs to the present CP-1 (Common Program 1) and UP-3 programs are presented. ESA

**N93-19578#** Southampton Univ. (England). Dept. of Physics.
**REAL AND SPURIOUS ANTICORRELATIONS BETWEEN V(PARALLEL) AND V(PERPENDICULARS) IN EISCAT DATA Abstract Only** **c32**
A. R. Breen and P. J. S. Williams (University Coll. of Wales, Aberystwyth.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Tristatic measurements of the field parallel and field perpendicular components of the plasma velocity in the F2 layer made by the EISCAT radar system frequently show evidence of an anticorrelation between these components, with no detectable lag of V(parallel) from antiphase of V(perpendiculars). It can be shown that spurious anticorrelations between V(parallel) and V(perpendiculars) may be introduced by random noise errors in measurements made at the individual sites being combined in the tristatic calculation. An alternative method of calculating the field parallel plasma velocity is suggested, and it is shown that, when the signal to noise ratio is sufficiently high, genuine anticorrelations between the variations of V(parallel) and V(perpendiculars) may be detected by this method. ESA

**N93-19579#** EISCAT Scientific Association, Kiruna (Sweden).
**THE EISCAT UHF RADAR AS A METEOR RADAR: METEOR RADIAL VELOCITIES DETERMINED FROM A BARKER CODED POWER PROFILE Abstract Only** **c32**
Gudmund Wannberg and Asta Pellinen-Wannberg (Swedish Inst. of Space Physics, Kiruna.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Under certain conditions, Barker coded power profiles with baud lengths of a few microns can be used to measure Doppler velocities in the interesting range in addition to serving their basic purpose of measuring electron densities. The method is based on the fact that the range ambiguity function of a Barker coded modulation is singly peaked when the target velocity is so small that the phase shift across the code is a small fraction of a full turn, but collapses into a successfully broader, multiply peaked response as the phase shift increases. Meteors moving through the beam with constant speed should then produce echos which would appear to be very broad in range but which would also have a symmetric multiple peak structure. These echos could then be fitted for velocity and range using a simple hard target, constant velocity model. An overview of an experiment designed to study the relationship between the Geminids meteor shower and the possible occurrence of sporadic E is given together with a display of typical raw power profiles, and the results of the range velocity fit are compared to present best estimates of the speed and disintegration height of Geminid meteors. ESA

**N93-19580#** EISCAT Scientific Association, Ramfjordbotn (Norway).
**ENHANCED ION-ACOUSTIC LINES IN EISCAT'S COMMON PROGRAMMES Abstract Only** **c32**
M. T. Rietveld, P. N. Collis (EISCAT Scientific Association, Kiruna, Sweden), A. P. vanEyken, K. Groves (Massachusetts Inst. of Tech., Westford.), and K. Tuovinen (EISCAT Scientific Association, Kiruna, Sweden ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Since the recent discovery of strongly enhanced but short lived ion acoustic lines in some of EISCAT's experiments, the need for an automatic means of detecting such echoes, preferably in real time, became apparent. An algorithm which finds and stores, in real time as well as from archived data, long pulse spectra with large asymmetries is in use. Spectra resulting both from echoes off orbiting satellites as well as the enhanced ion acoustic shoulders caused by large thermal drifts are found, but the latter are usually distinguishable from the former by their range extent, duration, and spectra width. Preliminary results of searching through data from Common Programs 1,2,3, and 5 are presented in the form of a statistical survey. Most of the hundreds of spectra found with enhanced shoulders come from field aligned antenna positions, but spectra have also been found at other aspect angles. Enhancements in the common volume are difficult to find, because of the combined effects of an occurrence minimum at about 250 km and the remote site antenna scans to the E region. The occurrence statistics and characteristics of the spectra are presented as functions of height, aspect angle, time, and season. Correlations are shown with other geophysical parameters such as electron temperature, occurrence of aurora, and ion upflows. Possible interpretations and implications of these data are presented. ESA

**N93-19581#** EISCAT Scientific Association, Kiruna (Sweden).
**EISCAT RADAR OBSERVATIONS OF ENHANCED INCOHERENT SCATTER SPECTRA: THEIR RELATION TO RED AURORA AND FIELD-ALIGNED CURRENTS Abstract Only** **c32**
P. N. Collis, I. Haeggstroem (Swedish Inst. of Space Physics, Kiruna.), Kari U. Kaila (Oulu Univ., Finland ), and M. T. Rietveld (EISCAT Scientific Association, Ramfjordbotn, Norway ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Enhancements of one or both of the ion acoustic peaks of incoherent scatter spectra in the auroral ionosphere were observed with the EISCAT UHF and VHF radars. All such occurrences for which optical data are available show these events to coincide with times when active, unusually intense, red auroral forms were in the vicinity of the radar beam at high altitudes. Both the optical and the radar signatures are expected to be caused by large fluxes of low energy electrons. Analyses of the measured spectra, in which the electron drift speed is estimated, imply field aligned current densities up to several mA/sq m. The vertically directed VHF observations from approximately 1000 km altitude reveal that the spectral enhancements, which are transient features in field aligned measurements, can exist for up to several minutes. ESA

**N93-19582#** EISCAT Scientific Association, Kiruna (Sweden).
**TURBULENCE SCATTERING LAYERS IN THE MIDDLE-MESOSPHERE OBSERVED BY THE EISCAT 224 MHz RADAR Abstract Only**
P. N. Collis, M. T. Rietveld (EISCAT Scientific Association, Ramfjordbotn, Norway ), J. Roettger, and W. K. Hocking (Adelaide Univ., Australia ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Spectral measurements of signals from altitudes well below 70 km were obtained with the EISCAT 224 MHz radar. Observations with the antenna pointing away from the vertical, show spectral power distributions departing markedly from those expected from collision dominated incoherent scatter theory. Separated peaks in the spectra occur in regions of abrupt shear in the velocity of the neutral wind within the scattering volume. Anomalously large backscattered power levels are sometimes observed in the vicinity of such shears at altitudes near 68 km. It is unlikely that these echoes are due to incoherent (Thomson) scatter. Instead, it is proposed that the abrupt velocity shears develop neutral turbulence in narrow layers, and that these layers cause the enhanced backscatter. Calculations of the expected backscatter power levels at 224 MHz for incoherent scatter and for turbulence scatter show that the turbulence component can be the dominant one at heights below about 68 km if the potential refractive index gradient and the turbulence energy dissipation rates are large enough. ESA

**N93-19583#** Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany).
**NO(+)-ENHANCEMENT IN THE HEIGHT RANGE BETWEEN 180 AND 300 km DURING ION HEATING EVENTS Abstract Only**
N. Glatthor *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

At times of enhanced convective electric fields (e.g. at substorm onset), the F region ions drift in E by B direction and are heated by collisions with the neutrals at a time scale of the order of seconds. Besides several other effects model calculations predict an increase of the NO(+) concentration throughout all the F layer during ion heating events, because the conversion of O(+) to NO(+) is assumed to be strongly energy dependent. However it is difficult to derive the O(+):NO(+) ratio directly from the shape of the radar spectra. The O(+):NO(+) ratio during several ion heating events is calculated from the measured height profiles of the ion temperature. At maximum ion drift the height profiles show relative minima of several 100 K between 230 and 250 km, as compared to the lower and upper F region. These minima are thought to be due to an enhancement of the NO(+) concentration, which is interpreted as a lower ion tolerance by the standard EISCAT fit. Further the O(+):NO(+) ratio is calculated from the chemical region equations, considering the temperature dependence of the reaction rates. The results of the calculations show that the NO(+) concentration below 270 km increases considerably during ion heating events. The transition zone from molecular ion to O(+) dominance can rise from 200 km up to more than 240 km. ESA

**N93-19584#** Grassmann (Volker), Wuppertal (Germany).
**THE EFFECT OF DIFFERENT COLLISION OPERATORS ON THE STANDARD DATA ANALYSIS MODEL Abstract Only** **c75**
Volker Grassmann *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

A recent model of incoherent scattering is adopted for the case of a collisional plasma without external forces. However the BGK (Bhatnagar-Gross-Krook equation) collision term in its density conservative form is replaced by the BGK collision term in its density, momentum, and energy conservative form. It is shown that the original standard model overweights the action of particle collisions by about 60 percent. The same result is obtained by using the generalized Fokker-Planck collision term. The latter collision operator is more sophisticated, but Stubbe's BGK approach is more suitable for practical purposes. ESA

**N93-19585#** Technische Univ., Brunswick (Germany).
**INTERNATIONAL MONITOR FOR AURORAL GEOMAGNETIC EFFECTS (IMAGE): A NEW MAGNETOMETER NETWORK IN SCANDINAVIA Abstract Only**
H. Luehr, Armin Grafe (Heinrich-Hertz-Inst. fuer Atmosphaerenforschung und Geomagnetismus, Niemegk, Germany ), R. Pellinen (Finnish Meteorological Inst., Helsinki.), and E. Kataja (Geophysical Observatory, Sodankyla, Finland ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

During the last decade the EISCAT magnetometer cross has sampled a whole wealth of good data. IMAGE is the substitute for the earlier network. The main difference is that it will provide a longer north-south profile, from the Norwegian coast down the south of Finland. Prime objectives of the network will be to support the upcoming satellite projects Freja and Interball. The long profile allows simultaneous observation of the eastward and westward electrojets and permits the dynamics of both to be compared. In cooperation with the SAMNET stations the whole array will be a powerful tool to study auroral and subauroral wave phenomena. ESA

**N93-19586#** EISCAT Scientific Association, Ramfjordbotn (Norway).
**NATURALLY ENHANCED ION-ACOUSTIC WAVES IN THE AURORAL IONOSPHERE OBSERVED WITH THE EISCAT 933 MHz RADAR Abstract Only**
M. T. Rietveld, P. N. Collis (EISCAT Scientific Association, Kiruna, Sweden), and J.-P. Saint-Maurice (University of Western Ontario, London.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Observations of strongly enhanced ion acoustic shoulders of the incoherent scatter spectrum at 933 MHz at altitudes from 138 km to 587 km were obtained with the EISCAT UHF radar. The enhancements can be up to one or two orders of magnitude in total backscattered power and can occur at either one or both of the ion-acoustic shoulders. These unusual spectra appear in two preferred height regions having different characteristics, one below 200 km and one above about 350 km. The enhancements are associated with geomagnetic disturbance, high electron temperatures, auroral arc, and red aurora in the F region. The observations, which are mainly along the magnetic field direction, indicate that field aligned thermal electron drifts are destabilizing the ion acoustic waves. They confirm and extend the one other publication reporting on similar echoes. Field aligned flows of soft electrons depositing their energy at horizontally poor conducting G region heights are suggested as being the cause of parallel electric fields in the ionosphere. These fields then produce the thermal electron motions that are argued to be the cause of the observations. ESA

**N93-19587#** Academy of Sciences (USSR), Murmansk. Polar Geophysical Inst.
**THE BICORE PROJECT Abstract Only** **c32**

Yu. Shchers, I. Sakharov, and M. Uspensky *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Project BICORE (Bistatic Coherent scatter Radar Experiment) is a proposal for a new 400 MKz continuous wave auroral radar facility in Karelia. Observational area of the BICORE radar covers the Kola peninsula as well as the area controlled by the EISCAT radars. The radar is planned to be built using existing industrial equipment which should be disconnected, moved, and reconnected in Karelia. The BICORE radar uses the same frequency band as the polar cap radar. The TX power can be from 10 to a few hundred kW, and allows (in principal), planning of cross receiving of signals over the EISCAT area. The TX antenna beam 0.3 to 0.4 deg in its azimuth width is frequency controlled. The remote RX site has multibeam antenna matrix where the width of each beam is around 1.5 deg. The important feature of the new auroral radar is the direct method of measuring the irregularity drift velocity which was not involved in the space convolution effect of the two or multipulse methods. The spatial resolution of the BICORE radar is approximately 5 by 60 sq km. The BICORE radar will be open for experiments for all EISCAT community members as well as for associated members. ESA

**N93-19588#** Swedish Inst. of Space Physics, Uppsala.
**OBSERVATIONS OF Pc5 ALFVEN WAVE EFFECTS IN THE QUIET TIME AURORAL IONOSPHERE: INDICATIONS OF ENERGETIC PARTICLE ACCELERATION Abstract Only**
J.-E. Wahlund, H. J. Opgenoorth, A. I. Eriksson, Maths A. L. Persson, and I. Haeggstroem (Swedish Inst. of Space Physics, Kiruna.) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

EISCAT observations of periodic variations in the perpendicular electric field, topside ionospheric electron temperature, and weak E region ionization with a period beween 3 to 4 mHz are presented. The six hour long event occurred during quiet auroral conditions with a moderately strong F layer and almost absent E layer. The weak E region pulsations in electron density were well below 1.0 x 10(exp 11) cu m and occurred in the altitude interval 105 to 140 km indicating weak precipitation around 5 to 20 keV. The more energetic particles were usually leading the somewhat softer precipitation by about 1 minute. Electron temperature pulsations above 300 km showed enhancements of about 1000 K which probably cannot be explained by the very weak particle precipitation. The pulsations in the perpendicular electric field had amplitudes around 15 mV/m and seemed to be eliptically polarized and anticorrelated with the pulsations in electron temperatures and E region electron density. The averaged background perpendicular electric field was near 0 mV/m. Alfvenic waves are suggested to explain the observations. ESA

**N93-19589#** University Coll. of Wales, Aberystwyth. Dept. of Physics.
**OVERALL RESULTS FROM THE EUROPEAN SECTOR OF THE WORLDWIDE ATMOSPHERIC GRAVITY-WAVE STUDY: 1985-1990 Abstract Only**
P. J. S. Williams, M. Lester (Leicester Univ., England ), I. McCrea (Rutherford Appleton Lab., Chilton, England ), T. S. Virdi, and R. V. Lewis *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

Campaigns to study the relationship between the generation of large scale waves in the high latitude thermosphere, and the propagation of such waves to lower latitudes, were held. EISCAT was used to estimate Joule heating and Lorentz forcing in the auroral electrojet by making high resolution measurements of electric field strength and electron concentration. Magnetometer records indicated the geographical extent of the auroral activity. At mid-latitudes an HF Doppler network and a number of ionosondes were used to monitor the horizontal propagation and vertical structure of the waves. On frequent occasions, especially after sunset, an unambiguous link was observed between the onset of enhanced activity in the electrojet and the subsequent arrival of a large scale gravity wave at mid-latitude. During the afternoon sector, however, strong auroral events were sometimes observed with only weak signs of wave activity in the farfield. This is due partly to attenuation through ion drag and partly to reduced sensitivity of the measuring techniques in the daytime ionosphere. In a number of cases it was possible to relate time variation in the source to the period of the wave itself; as expected, the components of longer period propagate furthest before dissipation. ESA

**N93-19828#** Lawrence Livermore National Lab., CA.
**OPAL OPACITIES**
F. J. Rogers and C. A. Iglesias Aug. 1992 9 p Presented at the GOND 1992: Seismic Investigation of the Sun and Stars, Boulder, CO, 11-14 Aug. 1992
(Contract W-7405-eng-48)
(DE93-002891; UCRL-JC-110144; CONF-9208181-1) Avail: CASI HC A02/MF A01

We have continued to improve and update the OPAL opacity code. Addition of intermediate coupling has further increases the opacity over earlier LS coupling results. A corresponding states method has been used to extend the tables in both X and Z. This has allowed the calculation and distribution of extensive opacity tables for several different sets of metal abundance. DOE

**N93-18501#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**SOLAR-TERRESTRIAL PHYSICS AND ASTROPHYSICS**
R. J. Rudy, J. B. Blake, M. C. McNab, M. Schulz, and D. L. McKenzie *In its* Aerospace Sponsored Research 1 Dec. 1991 p 134-137 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

**N93-18554*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**COSMIC DUST**
Donald E. Brownlee (Washington Univ., Seattle.) and Scott A. Sandford *In its* Exobiology in Solar Research Exploration Aug. 1992 p 145-158 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

**N93-18555*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**ORGANIC MATERIAL: ASTEROIDS, METEORITES, AND PLANETARY SATELLITES**
Dale P. Cruikshank and John F. Kerridge (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In its* Exobiology in Solar System Exploration Aug. 1992 p 159-176 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

**N93-18556*#** Toledo Univ., OH. Dept. of Physics and Astronomy.
**COMETS: ROLE AND IMPORTANCE TO EXOBIOLOGY**
Armand H. Delsemme *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 177-198 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

**N93-18558*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**CRAF MISSION: AN OPPORTUNITY FOR EXOBIOLOGY**
Marcia Neugebauer and Paul Weissman *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 215-228 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

## 91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.

For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**N93-17999*#** Massachusetts Inst. of Tech., Cambridge. Space Systems Engineering.
**PROJECT COLUMBIAD: MISSION TO THE MOON. BOOK 2, VOLUME 3: STAGE CONFIGURATION DESIGNS; VOLUME 4: PROGRAM PLAN**

1992 457 p
(Contract NASw-4435)
(NASA-CR-192037; NAS 1.26:192037) Copyright Avail: CASI HC A20/MF A04

The Earth Orbital Rendezvous (EOR) configuration for the piloted mission is composed of three propulsive elements in addition to the Crew Module (CM): Primary Trans-Lunar Injection (PTLI), Lunar Braking Module (LBM), and Earth Return Module (ERM). The precursor mission is also composed of three propulsive elements in addition to its surface payloads: PTLI, LBM and the Payload Landing Module (PLM). Refer to Volume 1, Section 5.1 and 5.2 for a break-up of the different stages into the four launches. A quick summary is as follows: PTLI is on Launch 1 and 3 while the LBM, PLM, and surface payloads are on Launch 2 and another LBM, ERM, and CM on Launch 4. The precursor mission is designed to be as modular as possible with the piloted mission for developmental cost considerations. The following topics are discussed: launch vehicle description; primary trans-lunar injection stage; lunar braking module; earth return module; crew module; payload landing module; and surface payload description. Author

**N93-18021#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**PROJECT ARES: A SYSTEMS ENGINEERING AND OPERATIONS ARCHITECTURE FOR THE EXPLORATION OF MARS**
Michael J. Miglioranzi, Jeff M. Berger, David J. Blaufuss, Richard W. Boltz, and Michael T. Dunn 20 Mar. 1992 220 p
(AD-A258082; AFIT/EN/TR-92-7; GSO-92D) Avail: CASI HC A10/MF A03

The authors, a group of 18 veteran space operations officers, explored the concept of placing a permanently manned station on Mars - Project Ares. Using a five phase plan involving an early moon base and three scientific missions to Mars followed by cargo missions and eventually manned trips to the planet, the authors analyzed, designed, and documented their approach. The report focuses on the second phase of the project - scientific expansion of our knowledge of Mars and proof of a reliable transportation system. Among the subjects discussed in the report are management, mission profile and environment, and mission systems. The latter subject contains a variety of systems proposed by various authorities in the space industry and selected to fulfill the unique requirements of the project. Because this phase is an integral part of the project, emphasis was on reusability and versatility. GRA

**N93-18038*#** Naval Academy, Annapolis, MD.
**LOLA: THE LUNAR OPERATIONS LANDING ASSEMBLY**
Mike Abreu, Fernando Argeles, Chris Stewart, Charles Turner, and Gavino Rivas 1 May 1992 73 p
(Contract NASw-4435)
(NASA-CR-192043; NAS 1.26:192043) Avail: CASI HC A04/MF A01

Because the President of the United States has begun the Space Exploration Initiative (SEI), which entails a manned mission to Mars by the year 2016, it is necessary to use the Moon as a stepping stone to this objective. In support of this mission, unmanned scientific exploration of the Moon will help re-establish man's presence there and will serve as a basis for possible lunar colonization, setting the stage for a manned Mars mission. The lunar landing platform must provide support to its payload in the form of power, communications, and thermal control. The design must be such that cost is held to a minimum, and so that a wide variety of payloads may be used with the lander. The objectives of this mission are (1) to further the SEI by returning to the moon with unmanned scientific experiments, (2) to demonstrate to the public that experimental payload missions are feasible, (3) to provide a common lunar lander platform so select scientific packages could be targeted to specific lunar locales, (4) to enable the lander to be built from off-the-shelf hardware, and (5) to provide first mission launch by 1996. Author

**N93-18048*#** Washington Univ., Seattle. Dept. of Aeronautics and Astronautics.
**PROJECT MINERVA: A LOW COST MANNED MARS MISSION BASED ON INDIGENOUS PROPELLANT PRODUCTION Final Report**
David Beder, Richard Bryan, Tuyen Bui, Kelly Caviezel, Mark Cinnamon, Todd Daggert, Mike Folkers, Mark Fornia, Natasha Hanks, and Steve Hamilton et al 15 Jun. 1992 621 p
(Contract NASw-4435)
(NASA-CR-192020; NAS 1.26:192020) Avail: CASI HC A99/MF A06

Project Minerva is a low-cost manned Mars mission designed to deliver a crew of four to the Martian surface using only two sets of two launches from the Kennedy Space Center. Key concepts which make this mission realizable are the use of near-term technologies and in-situ propellant production, following the scenario originally proposed by R. Zubrin. The first set of launches delivers two unmanned payloads into low Earth orbit (LEO): the first payload consists of an Earth Return Vehicle (ERV), a propellant production plant, and a set of robotic vehicles; the second payload consists of the trans-Mars injection (TMI) upper stage. In LEO, the two payloads are docked and the configuration is injected into a Mars transfer orbit. The landing on Mars is performed with the aid of multiple aerobraking maneuvers. On the Martian surface, the propellant production plant uses a Sabatier/electrolysis type process to combine nine tons of hydrogen with carbon dioxide from the Martian atmosphere to produce over a hundred tons of liquid oxygen and liquid methane, which are later used as the propellants for the rover expeditions and the manned return journey of the ERV. The systems necessary for the flights to and from Mars, as well as those needed for the stay on Mars, are discussed. These systems include the transfer vehicle design, life support, guidance and communications, rovers and telepresence, power generation, and propellant manufacturing. Also included are the orbital mechanics, the scientific goals, and the estimated mission costs. Author

**N93-18233*#** Massachusetts Inst. of Tech., Cambridge. Space Systems Engineering.
**PROJECT COLUMBIAD: MISSION TO THE MOON. BOOK 1: EXECUTIVE SUMMARY. VOLUME 1: MISSION TRADE STUDIES AND REQUIREMENTS. VOLUME 2: SUBSYSTEM TRADE STUDIES AND SELECTION**
Michael Clarke, Johan Denecke, Suzanne Garber, Beth Kader, Celia Liu, Ben Weintraub, Patrick Cazeau, John Goetz, James Haughwout, and Erik Larson et al 1992 587 p
(Contract NASw-4435)
(NASA-CR-192019; NAS 1.26:192019) Avail: CASI HC A25/MF A06

In response to the Report of the Advisory Committee on the future of the U.S. Space Program and a request from NASA's Exploration Office, the MIT Hunsaker Aerospace Corporation (HAC) conducted a feasibility study, known as Project Columbiad, on reestablishing human presence on the Moon before the year 2000. The mission criteria established were to transport a four person crew to the lunar surface at any latitude and back to Earth with a 14-28 day stay on the lunar surface. Safety followed by cost of the Columbiad Mission were the top level priorities of HAC. The resulting design has a precursor mission that emplaces the required surface payloads before the piloted mission arrives. Both the precursor and piloted missions require two National Launch System (NLS) launches. Both the precursor and piloted mission have an Earth orbit rendezvous (EOR) with a direct transit to the Moon post-EOR. The piloted mission returns to Earth via a direct transit. Included among the surface payloads preemplaced are a habitat, solar power plant (including fuel cells for the lunar night), lunar rover, and mechanisms used to cover the habitat with regolith (lunar soil) in order to protect the crew members from severe solar flare radiation. Author

**N93-18569*#** Space Telescope Science Inst., Baltimore, MD.
**TEACHING, LEARNING, AND PLANETARY EXPLORATION Progress Report, 1 May - 30 Sep. 1992**
Robert A. Brown 14 Dec. 1992 40 p
(Grant NAGw-3048)
(NASA-CR-192000; NAS 1.26:192000) Avail: CASI HC A03/MF A01

The progress accomplished in the first five months of the three-year grant period of Teaching, Learning, and Planetary Exploration is presented. The objectives of this project are to discover new education products and services based on space science, particularly planetary exploration. An Exploration in Education is the umbrella name for the education projects as they are seen by teachers and the interested public. As described in the proposal, our approach consists of: (1) increasing practical understanding of the potential role and capabilities of the research community to contribute to basic education using new discoveries; (2) developing an intellectual framework for these contributions by supplying criteria and templates for the teacher's stories; (3) attracting astronomers, engineers, and technical staff to the project and helping them form productive education partnerships for the future, (4) exploring relevant technologies and networks for authoring

and communicating the teacher's stories; (5) enlisting the participation of potential user's of the teacher's stories in defining the products; (6) actually producing and delivering many educationally useful teacher's stories; and (7) reporting the pilot study results with critical evaluation. Technical progress was made by assembling our electronic publishing stations, designing electronic publications based on space science, and developing distribution approaches for electronic products. Progress was made addressing critical issues by developing policies and procedures for securing intellectual property rights and assembling a focus group of teachers to test our ideas and assure the quality of our products. The following useful materials are being produced: the TOPS report; three electronic 'PictureBooks'; one 'ElectronicArticle'; three 'ElectronicReports'; ten 'PrinterPosters'; and the 'FaxForum' with an initial complement of printed materials. We have coordinated with planetary scientists and astronomers both at the technical and policy level to assure the efficiency and ultimate utility of these efforts to derive educational benefits from the space science and exploration program as a whole. Author

**N93-18779*#** Delaware Univ., Newark. Bartol Research Inst.
**MAGNETIC FIELD WAVES AT URANUS Semiannual Report**
Charles W. Smith, Melvyn L. Goldstein, Ronald P. Lepping, William H. Mish, and Hung K. Wong 26 Jul. 1991 8 p
(Grant NAGw-1514)
(NASA-CR-192113; NAS 1.26:192113) Avail: CASI HC A02/MF A01

The proposed research efforts funded by the UDAP grant to the BRI involve the study of magnetic field waves associated with the Uranian bow shock. This is a collaborative venture bringing together investigators at the BRI, Southwest Research Institute (SwRI), and Goddard Space Flight Center (GSFC). In addition, other collaborations have been formed with investigators granted UDAP funds for similar studies and with investigators affiliated with other Voyager experiments. These investigations and the corresponding collaborations are included in the report. The proposed effort as originally conceived included an examination of waves downstream from the shock within the magnetosheath. However, the observations of unexpected complexity and diversity within the upstream region have necessitated that we confine our efforts to those observations recorded upstream of the bow shock on the inbound and outbound legs of the encounter by the Voyager 2 spacecraft. Author

**N93-18782*#** California Inst. of Tech., Pasadena. Div. of Geological and Planetary Sciences.
**DYNAMICS OF PLANETARY ATMOSPHERES Final Technical Report, Jul. 1979 - Nov. 1989**
Andrew P. Ingersoll 1989 11 p
(Grant NAGw-58)
(NASA-CR-192117; NAS 1.26:192117) Avail: CASI HC A03/MF A01

The overall goal is to illuminate the mechanisms that control weather and climate on the Earth and other planets. Each planet presents its own puzzling behavior - the stability of jets and vortices in Jupiter's otherwise turbulent atmosphere, the superrotation of the Venus atmosphere, the interplay of dust, polar volatiles, and climate change in Mars, the supersonic meteorology of Io, and the counterintuitive equator-to-pole temperature gradients on the outer planets. The data sets are generally those obtained from spacecraft - cloud-tracked winds, radiometrically inferred temperatures, and the results of in situ observations where appropriate. The approach includes both data analysis and modeling, ranging from analytic modeling to time-dependent numerical modeling of atmospheric dynamics. The latter approach involves the use of supercomputers such as the San Diego Cray. Progress is generally made when a model with a small number of free parameters either fits a data set that has a large number of independent observations or applies to several planets at once. Author

**N93-18786*#** Lunar Science Inst., Houston, TX.
**WORKSHOP ON GEOLOGY OF THE APOLLO 17 LANDING SITE**
G. Ryder, ed., H. H. Schmitt, ed., and P. D. Spudis, ed. 2 Dec. 1992 70 p Workshop held in Houston, TX, 2-4 Dec. 1992 Sponsored by Lunar and Planetary Sample Team, Lunar and Planetary Institute
(Contract NASw-4574)
(NASA-CR-191637; LPI-TR-92-09; NAS 1.26:191637) Avail: CASI HC A04/MF A01

The topics covered include the following: petrology, lithology, lunar rocks, lunar soil, geochemistry, lunar geology, lunar resources, oxygen production, ilmenite, volcanism, highlands, lunar maria, massifs, impact melts, breccias, lunar crust, Taurus-Littrow, minerals, site selection, regolith, glasses, geomorphology, basalts, tectonics, planetary evolution, anorthosite, titanium oxides, chemical composition, and the Sudbury-Serenitatis analogy. For individual titles, see N93-18787 through N93-18817.

**N93-18787*#** Lockheed Engineering and Sciences Co., Houston, TX.
**LUNAR RESOURCES: OXYGEN FROM ROCKS AND SOIL**
C. C. Allen, M. A. Gibson (Carbotek, Inc., Houston, TX.), C. W. Knudsen (Carbotek, Inc., Houston, TX.), H. Kanamori (Shimizu Corp., Japan ), R. V. Morris (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.), L. P. Keller (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.), and D. S. McKay (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 1-2 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The first set of hydrogen reduction experiments to use actual lunar material was recently completed. The sample, 70035, is a coarse-grained vesicular basalt containing 18.46 wt. percent FeO and 12.97 wt. percent TiO2. The mineralogy includes pyroxene, ilmenite, plagioclase, and minor olivine. The sample was crushed to a grain size of less than 500 microns. The crushed basalt was reduced with hydrogen in seven tests at temperatures of 900-1050 C and pressures of 1-10 atm for 30-60 minutes. A capacitance probe, measuring the dew point of the gas stream, was used to follow reaction progress. Experiments were also conducted using a terrestrial basalt similar to some lunar mare samples. Minnesota Lunar Simulant (MLS-1) contains 13.29 wt. percent FeO, 2.96 wt. percent Fe2O3, and 6.56 wt. percent TiO2. The major minerals include plagioclase, pyroxene, olivine, ilmenite, and magnetite. The rock was ground and seived, and experiments were run on the less than 74- and 500-1168-micron fractions. Experiments were also conducted on less than 74-micron powders of olivine, pyroxene, synthetic ilmenite, and TiO2. The terrestrial rock and mineral samples were reduced with flowing hydrogen at 1100 C in a microbalance furnace, with reaction progress monitored by weight loss. Experiments were run at atmospheric pressure for durations of 3-4 hr. Solid samples from both sets of experiments were analyzed by Mossbauer spectroscopy, petrographic microscopy, scanning electron microscopy, tunneling electron microscopy, and x-ray diffraction. Apollo 17 soil 78221 was examined for evidence of natural reduction in the lunar environment. This sample was chosen based on its high maturity level (I sub s/FeO = 93.0). The FeO content is 11.68 wt. percent and the TiO2 content is 3.84 wt. percent. A polished thin section of the 90-150 micron size fraction was analyzed by petrographic microscopy and scanning electron microscopy. Author

**N93-18788*#** Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences and McDonnell Center for the Space Sciences.
**NORTH MASSIF LITHOLOGIES AND CHEMICAL COMPOSITIONS VIEWED FROM 2-4 mm PARTICLES OF SOIL SAMPLE 76503**
Kaylynn M. Bishop, Bradley L. Jolliff, Randy L. Korotev, and Larry A. Haskin *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 2-4 (For primary document see N93-18786 06-91)
(Grant NAG9-56)
Avail: CASI HC A01/MF A01

We identify the lithologic and compositional components of soil 76503 based on INAA of 243 2-4-mm particles and 72 thin sections from these and associated 1-2-mm particles (76502). We present a statistical distribution of the major compositional types as the first step of a detailed comparative study of the North and South Massifs. The soil sample was collected well away from any boulder and is more representative of typical North Massif material than any single large rock or boulder sample. So far, our examination of the 76503 particles has provided a better definition of precursor igneous lithologies and their petrogenetic relationships. It has enabled us to refine the nature of mixing components for the North Massif less than 1-mm fines. It has confirmed the differences in lithologies and their proportions between materials of the North and South Massifs; e.g., the North Massif is distinguished by the absence of a 72275-type KREEP component, the abundance of a highly magnesian igneous component, and the absence of certain types of melt compositions found in the South Massif samples. Author

**N93-18789*#** Hawaii Univ., Manoa. Dept. of Geology and Geophysics.
**REFINING THE GRANULITE SUITE**
G. Jeffrey Taylor, Marc D. Norman, Klaus Keil, and Janet A. Cushing *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 4-5 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

Early studies of rocks retrieved from the Moon during the Apollo missions defined a group of rocks as granulites or 'granulitic impactites'. This included rocks with cataclastic, granulitic, and poikilitic or poikiloblastic textures. Petrographic studies indicate that the textures of 'granulitic breccias' are significantly varied so as to redefine the granulitic suite into at least two distinct groups. The first group consists of rocks that have true granulitic textures: polygonal to rounded, equant grains that are annealed, and have triple junctions with small dispersions from the average 120 degrees. The second group of rocks have poikilitic or poikiloblastic textures, with subhedral to euhedral plagioclase and/or olivine grains enclosed in pyroxene oikocrysts. In some instances, the relationship between the minerals resembles an orthocumulate texture. Rocks previously thought of as granulites may have formed in more than one way. These formation mechanisms are briefly discussed. Author

**N93-18790*#** New York Univ., New York. Dept. of Geological Sciences.
**MARE VOLCANISM IN THE TAURUS-LITTROW REGION**
J. W. Delano *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 5-7 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The products of mare volcanism at Taurus-Littrow occur in the form of crystalline basalts and volcanic glass beads. Both categories of samples define a compositionally diverse, but petrogenetically unrelated, suite of magmas derived by partial melting of a heterogenous, differentiated mantle beneath the region of the Apollo 17 landing site. This is a brief review of what is known and what is not known about mare volcanism at this location on the Moon. Author

**N93-18791*#** New York Univ., New York. Dept. of Geological Sciences.
**ABUNDANCES OF SODIUM, SULFUR, AND POTASSIUM IN LUNAR VOLCANIC GLASSES: EVIDENCE FOR VOLATILE LOSS DURING ERUPTION**
J. W. Delano and J. McGuire (State Univ. of New York, Stony Brook.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 7-9 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

Six varieties of lunar volcanic glass are known to occur within the Apollo 17 sample collection. Investigations have shown that 25 volatile elements are known to be concentrated on the exterior surfaces of individual volcanic glass spheres. Since bulk analyses of volcanic glass provide an integrated abundance of an element on and with the glass spherules, other methods must be relied on to determine the interior abundance of an element. The interior abundance of an element with a volcanic glass sphere establishes the abundance of that element in the melt at the time of quench. The current study is part of a comprehensive attempt to measure the abundance of three volatile elements (Na, S, and K) within representative spheres of the 25 varieties of lunar volcanic glass currently known to exist at the Apollo landing sites. Comparison of the measured abundances of these elements within the interiors of individual glasses with bulk analyses and crystalline mare basalts will furnish new constraints on the geochemical behavior of volatile elements during lunar mare volcanism. Author

**N93-18792*#** Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences and McDonnell Center for the Space Sciences.
**RESOURCE AVAILABILITY AT TAURUS-LITTROW**
Larry A. Haskin and R. O. Colson *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 9-14 (For primary document see N93-18786 06-91)
Avail: CASI HC A02/MF A01

Early lunar technologies will probably use a common lunar material as ore. They will be robust to minor fluctuations in feedstock composition and will not require appreciable feedstock beneficiation such as rock grinding or mineral concentration. Technologies using unprocessed soil and indifferent to its composition will have the advantage. Nevertheless, the size and grade of the ore body must be confirmed for even the most indiscriminate process. Simple uses such as heaping unprocessed lunar soil for thermal insulation or radiation shielding onto a habitat require that we know the depth of the regolith, the size distributions of its soils, the locations of large boulders, and the ease of excavation. Costs of detailed site surveys trade against restrictions on site selection and conservative engineering design to accommodate unknown conditions of a poorly explored site. Given the above considerations, we consider briefly some abundant lunar materials, their proposed uses, and technologies for their preparation, with particular attention to the Taurus-Littrow site. Author

**N93-18793*#** Hawaii Univ., Honolulu. Planetary Geosciences.
**A SPECTRAL SURVEY OF THE SERENITATIS BASIN REGION OF THE MOON**
B. R. Hawke, C. A. Peterson, P. G. Lucey, D. T. Blewett, J. F. Bell, III (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.), and P. D. Spudis (Lunar and Planetary Inst., Houston, TX.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 14-15 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

In recent years, we have utilized the Apollo orbital geochemistry datasets and Earth-based spectral reflectance data to investigate the composition of highland units associated with lunar multiring basins. These include Imbrium, Orientale, and Nectaris Basins. We have also analyzed a large number of near-IR reflectance spectra and multispectral images in an attempt to answer a variety of questions concerning the Serenitatis Basin. These questions include the following: (1) What is the composition of highland units in the region and how do these compositions vary as a function of position around and distance from Serenitatis?; (2) What was the crustal stratigraphy of the Serenitatis preimpact target site?; (3) How do the Apollo 17 samples relate to geologic units in the surrounding highlands?; (4) What is the nature and origin of light plains deposits in the region?; and (5) Do cryptomare occur in the Serenitatis region? The purpose of this paper is to present the preliminary results of our analyses of spectral data obtained for the Serenitatis Basin region. Author

**N93-18794*#** Brown Univ., Providence, RI. Dept. of Geological Sciences.
**THE SERENITATIS BASIN AND THE TAURUS-LITTROW HIGHLANDS: GEOLOGICAL CONTEXT AND HISTORY**
James W. Head *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 15-17 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Apollo 17 mission was targeted to land at the southeastern edge of the Serenitatis Basin, one of a number of large impact basins on the Moon. The geologic setting of the Apollo 17 site is reviewed, the implications for the formation of basins from Apollo 17 results are assessed, and unanswered questions potentially addressable with existing and new data are outlined. Author

**N93-18795*#** Geological Survey, Reston, VA. National Center.
**THE ANCIENT LUNAR CRUST, APOLLO 17 REGION**
O. B. James *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 17-20 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Apollo 17 highland collection is dominated by fragment-laden melt rocks, generally thought to represent impact melt from the Serenitatis basin-forming impact. Fortunately for our understanding of the lunar crust, the melt rocks contain unmelted clasts of preexisting rocks. Similar ancient rocks are also found in the regolith; most are probably clasts eroded out of melt rocks. The ancient rocks can be divided into groups by age, composition, and history. Oldest are plutonic igneous rocks, representing the magmatic components of the ancient crust. The younger are granulitic breccias, which are thoroughly recrystallized rocks of diverse parentages. The youngest are KREEPy basalts and felsites, products of relatively evolved magmas. Some characteristics of each group are given. Author

**N93-18796*#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Aachen (Germany).
**THE APOLLO 17 REGION: A COMPOSITIONAL OVERVIEW**

R. Jaumann and G. Neukum *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 20-21 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

Apollo 17 is located at a mare/highland boundary where the surface shows significant compositional heterogeneities. The composition of surface materials is estimated by analyzing their spectral/chemical correlations. Based on this spectral/chemical analysis, the chemical and normative mineralogical composition of two highland units and three mare units has been estimated. Author

**N93-18797*#** Tennessee Univ., Knoxville. Dept. of Geological Sciences.
**neoKREEP: A NEW LUNAR COMPONENT AT APOLLO 17**
Eric A. Jerde, Gregory A. Snyder, and Lawrence A. Taylor *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 21-24 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Apollo 11 (Mare Tranquillitatis) and Apollo 17 (Mare Serenitatis) landing sites are important as the only sources of high-Ti basalt visited by the Apollo missions. The lunar high-Ti basalts (greater than 6 percent TiO2) have no volumetrically comparable analogs among terrestrial basalts and require the presence of ilmenite in the source region, probably representing cumulates produced late in the crystallization of the lunar magma ocean. Six principal groups of high-Ti basalts are described, three from each of the two sites. Author

**N93-18798*#** Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences and McDonnell Center for the Space Sciences.
**POSSIBLE PETROGENETIC ASSOCIATIONS AMONG IGNEOUS COMPONENTS IN NORTH MASSIF SOILS: EVIDENCE IN 2-4 mm SOIL PARTICLES FROM 76503**
Bradley L. Jolliff, Kaylynn M. Bishop, and Larry A. Haskin *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 24-26 (For primary document see N93-18786 06-91)
(Grant NAG9-56)
Avail: CASI HC A01/MF A01

Studies of Apollo 17 highland igneous rocks and clasts in breccias from the North and South Massifs have described magnesian troctolite, norite, anorthositic gabbro, dunite, spinel cataclasites, and granulitic lithologies that may have noritic anothosite or anorthositic norite/gabbro as igneous precursors, and have speculated on possible petrogenetic relationships among these rock types. Mineral compositions and relative proportions of plagioclase and plagioclase-olivine particles in samples 76503 indicate that the precursor lithology of those particles were troctolitic anorthosite, not troctolite. Mineral and chemical compositions of more pyroxene-rich, magnesian breccias and granulites in 76503 indicate that their precursor lithology was anorthositic norite/gabbro. The combination of mineral compositions and whole-rock trace-element compositional trends supports a genetic relationship among these two groups as would result from differentiation of a single pluton. Although highland igneous lithologies in Apollo 17 materials have been described previously, the proportions of different igneous lithologies present in the massifs, their frequency of association, and how they are related are not well known. We consider the proportions of, and associations among, the igneous lithologies found in a North Massif soil, which may represent those of the North Massif or a major part of it. Author

**N93-18799*#** Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
**THE APOLLO 17 REGOLITH**
Randy L. Korotev *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 26-29 (For primary document see N93-18786 06-91)
(Grant NAG9-56)
Avail: CASI HC A01/MF A01

Among Apollo landing sites, Apollo 17 provides the best opportunity to study the efficiency of formation and evolution of regolith by impacts, both large and small. The mare-highlands interface is crucial to this endeavor, but the Light Mantle avalanche and presence of fine-grained pyroclastics offer additional constraints. Compositional variation among soils from different locations and depths provides a means to quantify the extent of mixing by larger impacts. Because of their variety and complex history, Apollo 17 soils have been important in establishing agglutinate abundance, mean grain size, and abundance of fine-grained iron metal (as measured by (I(sub s)/FeO)) as simple index of maturity (relative extent of reworking by micrometeorite impact at the surface). The following topics are discussed: (1) surface soils; (2) cores taken on the mission; (3) gray soil from station 4; (4) components with unknown sources; (5) important points; and (6) future work. Author

**N93-18800*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**GEOCHEMISTRY OF HASP, VLT, AND OTHER GLASSES FROM DOUBLE DRIVE TUBE 79001/2**
D. J. Lindstrom, S. J. Wentworth (Lockheed Engineering and Sciences Co., Houston, TX.), R. R. Martinez (Lockheed Engineering and Sciences Co., Houston, TX.), and D. S. McKay *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 29-31 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Apollo 17 double drive tube 79001/2 (station 9, Van Serg Crater) is distinctive because of its extreme maturity, abundance, and variety of glass clasts. It contains mare glasses of both high Ti and very low Ti (VLT) compositions, and highland glasses of all compositions common in lunar regolith samples: highland basalt (feldspathic; Al2O3 greater than 23 wt percent), KREEP (Al2O3 less than 23 wt percent, K2O greater than 0.25 wt percent), and low-K Fra Mauro (LKFM; Al2O3 less than 23 wt percent, K2O less than 0.25 wt percent). It also contains rare specimens of high-alumina, silica-poor (HASP), and ultra Mg glasses. HASP glasses contain insufficient SiO2 to permit the calculation of a standard norm, and are thought to be the product of volatilization during impact melting. They have been studied by electron microprobe major-element analysis techniques but have not previously been analyzed for trace elements. The samples analyzed for this study were polished grain mounts of the 90-160 micron fraction of four sieved samples from the 79001/2 core (depth range 2.3-11.5 cm). A total of 80 glasses were analyzed by SEM/EDS and electron microprobe, and a subset of 33 of the glasses, representing a wide range of compositional types, was chosen for high-sensitivity INAA. A microdrilling device removed disks (mostly 50-100 micron diameter, weighing approx. 0.1-0.5 micro-g) for INAA. Preliminary data reported here are based only on short counts done within two weeks of irradiation. Author

**N93-18801*#** Geological Survey, Flagstaff, AZ.
**THE TAURUS-LITTROW DARK MANTLE, LIGHT MANTLE, CRATER CLUSTER, AND SCARP**
Baerbel K. Lucchitta *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 31 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Taurus-Littrow landing site is on the floor of a grabenlike valley that is radial to the Serenitatis Basin; the valley is gently inclined to the east. It is bordered by steep-sided massifs that rise 2 km above the valley floor and form part of the Serenitatis Basin rim. The valley floor is exceptionally dark, and in one place it is overlain by a light-colored mantle apparently derived from the massif to the south. The floor is also peppered by overlapping craters. A scarp, up on the west, transects the valley floor and enters the highlands to the north. Pre- and post-mission analyses of this geological formation are presented. Author

**N93-18802*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**MORPHOLOGY AND COMPOSITION OF CONDENSATES ON APOLLO 17 ORANGE AND BLACK GLASS**
David S. McKay and Sue J. Wentworth (Lockheed Engineering and Sciences Co., Houston, TX.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 31-36 (For primary document see N93-18786 06-91)
Avail: CASI HC A02/MF A01

Lunar soil sample 74220 and core samples 74001/2 consist mainly of orange glass droplets, droplet fragments, and their crystallized equivalents. These samples are now generally accepted to be pyroclastic ejecta from early lunar volcanic eruptions. It has been known since early examination of these samples that they contain surface coatings and material rich in volatile condensible phases, including S, Zn, F, Cl, and many volatile

metals. The volatiles associated with these orange and black glasses (and the Apollo 15 green glasses) may provide important clues in understanding the differentiation and volcanic history of the Moon. In addition, condensible volatiles can be mobilized and concentrated by volcanic processes. We have reviewed many of our existing photomicrographs and energy dispersive analysis (EDXA) of grain surfaces and have reexamined some of our older SEM mounts using an improved EDXA system capable of light-element detection and analysis (oxygen, nitrogen, and carbon). The results from these investigations are presented. Author

**N93-18803*#** Texas Univ., Austin.
**GEOLOGY OF THE APOLLO 17 SITE**
W. R. Muehlberger *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 36-37 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Apollo 17 landing site was unique in several aspects: (1) it was the only site that was not selected from telescopic-based geologic interpretation--interest in the site was generated by the visual observations of Al Worden, Apollo 15 Command Module pilot, who interpreted dark-haloed craters as possible cinder cones; (2) instead of 20-m-resolution photographs, as was the norm for all earlier missions, this site had Apollo 15 panoramic camera photography coverage that had 2-m resolution; and (3) it had a geologist-astronaut aboard who was intimately involved in all stages of planning and mission operation, and was also instrumental in the design of a long-handled sample bag holder that eliminated the need for crew to dismount before collecting a sample, which then permitted sampling between major stations. Details of site geology, sample description, and geologic synthesis of the site as viewed from studies through 1976 are summarized. Author

**N93-18804*#** Notre Dame Univ., IN. Dept. of Civil Engineering and Geological Sciences.
**THE APOLLO 17 MARE BASALTS: SERENELY SAMPLING TAURUS-LITTROW**
Clive R. Neal and Lawrence A. Taylor (Tennessee Univ., Knoxville.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 37-40 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

As we are all aware, the Apollo 17 mission marked the final manned lunar landing of the Apollo program. The lunar module (LM) landed approximately 0.7 km due east of Camelot Crater in the Taurus-Littrow region on the southwestern edge of Mare Serenitatis. Three extravehicular activities (EVA's) were performed, the first concentrating around the LM and including station 1 approximately 1.1 km south-southeast of the LM at the northwestern edge of Steno Crater. The second traversed approximately 8 km west of the LM to include stations 2, 3, 4, and 5, and the third EVA traversed approximately 4.5 km to the northwest of the LM to include stations 6, 7, 8, and 9. This final manned mission returned the largest quantity of lunar rock samples, 110.5 kg/243.7 lb, and included soils, breccias, highland samples, and mare basalts. This abstract concentrates upon the Apollo 17 mare basalt samples. Author

**N93-18805*#** Notre Dame Univ., IN. Dept. of Civil Engineering and Geological Sciences.
**USING APOLLO 17 HIGH-Ti MARE BASALTS AS WINDOWS TO THE LUNAR MANTLE**
Clive R. Neal and Lawrence A. Taylor (Tennessee Univ., Knoxville.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 40-41 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Apollo 17 high-Ti mare basalts are derived from source regions containing plagioclase that was not retained in the residue. Ilmenite appears to remain as a residual phase, but plagioclase is exhausted. The open-system behavior of the type B2 basalts results in slightly higher Yb/Hf and La/Sm ratios. The nature of the added component is not clear, but may be a KREEP derivative or residue. The recognition of plagioclase in the source(s) of these basalts suggests that the location of the source region(s) would be more likely to be less than 150 km (i.e., closer to the plagioclase-rich crust), which would allow incorporation of plagioclase into the source through incomplete separation of crustal feldspar. Author

**N93-18806*#** Hawaii Univ., Honolulu. Dept. of Geology and Geophysics.
**LITHOLOGIES CONTRIBUTING TO THE CLAST POPULATION IN APOLLO 17 LKFM BASALTIC IMPACT MELTS**
Marc D. Norman, G. Jeffrey Taylor, Paul Spudis (Lunar and Planetary Inst., Houston, TX.), and Graham Ryder (Lunar and Planetary Inst., Houston, TX.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 42-44 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

LKFM basaltic impact melts are abundant among Apollo lunar samples, especially those from Apollo 15, 16, and 17. They are generally basaltic in composition, but are found exclusively as impact melts. They seem to be related to basins and so could represent the composition of the lower lunar crust. They contain lithic clasts that cannot be mixed in any proportion to produce the composition of the melt matrix; components rich in transition elements (Ti, Cr, Sc) and REE are not considered. To search for the mysterious cryptic component, we previously investigated the mineral clast population in two Apollo 14 LKFM basaltic impact melts, 15445 and 15455. The cryptic component was not present in the mineral clast assemblage of these breccias either, but some olivine and pyroxene grains appeared to be from lithologies not represented among identified igneous rocks from the lunar highlands. In addition, none of the mineral clasts could be unambiguously assigned to a ferroan anorthosite source. We have now extended this study to Apollo 17, starting with two LKFM impact melt breccias (76295 and 76315) from the Apollo 17 station 6 boulder. The results from the study are presented. Author

**N93-18807*#** Georgia Univ., Athens. Dept. of Geology.
**IMPACT GLASSES FROM THE LESS THAN 20-MICROMETER FRACTION OF APOLLO 17 SOILS 72501 AND 78221**
John A. Norris, Lindsay P. Keller (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.), and David S. McKay (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 44-45 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The chemical compositions of microscopic glasses produced during meteoroid impacts on the lunar surface provide information regarding the various fractionation processes that accompany these events. To learn more about these fractionation processes, we studied the compositions of submicrometer glass spheres from two Apollo 17 sampling sites using electron microscopy. The majority of the analyzed glasses show evidence for varying degrees of impact-induced chemical fractionation. Among these are HASP glasses (high-Al, Si-poor), which are believed to represent the refractory residuum left after the loss of volatile elements (e.g., Si, Fe, Na) from the precursor material. In addition to HASP-type glasses, we also observed a group of volatile-rich, Al-poor (VRAP) glasses that represent condensates of vaporized volatile constituents, and are complementary to the HASP compositions. High-Ti glasses were also found during the course of this study, and are documented here for the first time. Author

**N93-18808*#** Geological Survey, Denver, CO.
**ISOTOPIC AGES AND CHARACTERISTICS OF ANCIENT (PRE-SERENITATIS) CRUSTAL ROCKS AT APOLLO 17**
W. R. Premo and M. Tatsumoto *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 45-48 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The topics covered include the following: (1) problems with the isotopic systematics in lunar samples; (2) ancient crustal ages at the Apollo 17 site; and (3) isotopic characteristics of ancient Apollo 17 rocks - implications for their petrogenesis. Author

**N93-18809*#** Lunar and Planetary Inst., Houston, TX.
**THE APOLLO 17 SAMPLES: THE MASSIFS AND LANDSLIDE**
Graham Ryder *In its* Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 48-49 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

More than 50 kg of rock and regolith samples, a little less than half

the total Apollo 17 sample mass, was collected from the highland stations at Taurus-Littrow. Twice as much material was collected from the North Massif as from the South Massif and its landslide (the apparent disproportionate collecting at the mare sites is mainly a reflection of the large size of a few individual basalt samples). Descriptions of the collection, documentation, and nature of the samples are given. A comprehensive catalog is currently being produced. Many of the samples have been intensely studied over the last 20 years and some of the rocks have become very familiar and depicted in popular works, particularly the dunite clast (72415), the troctolite sample (76535), and the station 6 boulder samples. Most of the boulder samples have been studied in Consortium mode, and many of the rake samples have received a basic petrological/geochemical characterization. Author

**N93-18810*#** Lunar and Planetary Inst., Houston, TX.
**IMPACT MELT BRECCIAS AT THE APOLLO 17 LANDING SITE**
Graham Ryder *In its* Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 49-50 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

Impact melt breccias are by far the most common highland rock type collected on the Apollo 17 mission. They tend to be fine grained, with virtually no clast-free impact melt rocks having been identified. All the highland boulders sampled are impact melt breccia, with the possible exception of one South Massif boulder that might have a friable matrix (but nonetheless consists dominantly of impact melt) and a shocked igneous norite boulder from the North Massif. The impact melt breccias were originally described as metaclastic, but their melt origin became apparent as work progressed. Chemical compositions appear to allow natural groupings of the impact melt breccias. Various groupings of the impact melt breccias are discussed. Author

**N93-18811*#** Lunar and Planetary Inst., Houston, TX.
**APOLLO 17: ONE GIANT STEP TOWARD UNDERSTANDING THE TECTONIC EVOLUTION OF THE MOON**
Virgil L. Sharpton *In its* Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 50-53 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

Our present understanding of the tectonic history of the Moon has been shaped in large measure by the Apollo Program, and particularly the Apollo 17 Mission. I attempt to summarize some of the interpretations that have emerged since Apollo 17, focusing on some of the problems and uncertainties that remain to stimulate future exploration of the Moon. The topics covered include: (1) Taurus-Littrow Valley; (2) origin of mare ridges; and (3) nature and timing of tectonic rille formation. Author

**N93-18812*#** Tennessee Univ., Knoxville. Dept. of Geological Sciences.
**MELTING OF COGNETIC DEPLETED AND ENRICHED RESERVOIRS AND THE PRODUCTION OF HIGH TI MARE BASALTS**
Gregory A. Snyder, Lawrence A. Taylor, and Alex N. Halliday (Michigan Univ., Ann Arbor.) *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 53-55 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

Implicit in current understanding of the location of terrestrial enriched and depleted reservoirs is the notion that they are spatially separated. The depleted reservoir on Earth is situated in the upper mantle, and the complementary enriched reservoir is located in the crust. However, Earth reservoirs are continually being modified by recycling driven by mantle convection. The Moon is demonstrably different from Earth in that its evolution was arrested relatively early - effectively with 1.5 Ga of its formation. It is possible that crystallized trapped liquids (from the late stages of a magma ocean) have been preserved as LILE-enriched portions of the lunar mantle. This would lead to depleted (cumulate) and enriched (magma ocean residual liquid) reservoirs in the lunar upper mantle. There is no evidence for significant recycling from the highland crust back into the mantle. Therefore, reservoirs created at the Moon's inception may have remained intact for over 4.0 Ga. The topics discussed include the following: (1) radiogenic isotopes in high-Ti mare basalts; (2) formation of cogenetic depleted and enriched reservoirs; and (3) melting of the source to achieve high-Ti mare basalts. Author

**N93-18813*#** Lunar and Planetary Inst., Houston, TX.
**BASALTIC IMPACT MELTS IN THE APOLLO COLLECTIONS: HOW MANY IMPACTS AND WHICH EVENTS ARE RECORDED?**
Paul D. Spudis *In its* Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 55-57 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

Many of the rocks in the Apollo collections from the lunar highlands are impact melt breccias of basaltic bulk composition. They are known by a variety of names including low-K Fra Mauro basalt, VHA basalt, and basaltic impact melts. These rocks have been studied to understand the compositional nature of the lunar crust, to decipher the processes of large body impact, and to comprehend the record of impact bombardment of the Moon. Study of terrestrial craters has led to a model for impact melt generation whereby target lithologies are totally melted during impact. The impact melt makes up a few percent of the total volume of crater material; superheated silicate liquids of the impact melt have extremely low viscosities and mix intimately. This mixing thoroughly homogenizes the melt chemically during the excavation of the crater. Colder, unmelted debris is overridden by the melt sheet as the crater cavity grows. Incorporation of these cold clasts rapidly chills the melt, with zones of greater and lesser amounts of clasts being primarily responsible for modestly differing thermal regimes. The net effect of this process is the production of a suite of rocks that have extreme chemical homogeneity, but wide petrographic diversity. Strict application of this model to the petrogenesis of basaltic impact melts from the Moon has some fairly significant consequences for how we interpret early lunar history. The consequences are briefly discussed. Author

**N93-18814*#** Hawaii Univ., Honolulu. Dept. of Geology and Geophysics.
**FUTURE SCIENTIFIC EXPLORATION OF TAURUS-LITTROW**
G. Jeffrey Taylor *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 57-59 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Apollo 17 site was surveyed with great skill and the collected samples have been studied thoroughly (but not completely) in the 20 years since. Ironically, the success of the field and sample studies makes the site an excellent candidate for a return mission. Rather than solving all the problems, the Apollo 17 mission provided a set of sophisticated questions that can be answered only by returning to the site and exploring further. This paper addresses the major unsolved problems in lunar science and points out the units at the Apollo 17 site that are most suitable for addressing each problem. It then discusses how crucial data can be obtained by robotic rovers and human field work. I conclude that, in general, the most important information can be obtained only by human exploration. The paper ends with some guesses about what we could have learned at the Apollo 17 site from a fairly sophisticated rover capable of in situ analyses, instead of sending people. Author

**N93-18815*#** California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics.
**THE SUDBURY-SERENITATIS ANALOGY AND 'SO-CALLED' PRISTINE NONMARE ROCKS**
Paul H. Warren *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 59-61 (For primary document see N93-18786 06-91)
Avail: CASI HC A01/MF A01

The Serenitatis Basin is the one lunar basin from which we confidently identify a suite of samples as pieces of the impact melt sheet: the distinctive Apollo 17 noritic breccias. Recent studies of the Sudbury Complex indicate that its 'irruptive' is almost entirely of impact-melt origin, making it the closest terrestrial analog to the Serenitatis melt sheet. Any attempt to model the evolution of the Moon's crust should be compatible with the relatively well-understood Sudbury Complex. However, the Sudbury-Moon analogy might be a misleading oversimplification, if applied too rigidly. The cause of evolutionary differences between the Serenitatis impact melt and the Sudbury impact melt is discussed. Author

**N93-18816*#** California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics.

**TROCTOLITIC ANORTHOSITE FROM 77115: A MAGNESIAN MEMBER OF THE ALKALIC SUITE**

Paul H. Warren and Gregory W. Kallemeyn *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 61 (For primary document see N93-18786 06-91)

Avail: CASI HC A01/MF A01

Alkalic suite pristine nonmare rocks are distinctly enriched in plagiophile elements such as Na and K, as well as generally incompatible elements, despite modes and textures more characteristic of typical crustal cumulates (most commonly anorthosites) than of the basaltic KREEP rocks that appear to account for the bulk of the lunar crust's total complement of incompatible elements. Our studies indicate that the 77115 troctolitic clasts of Winzer et al. is actually a troctolitic anorthosite (or anorthositic troctolite), probably best classified as a member of the alkalic suite. We managed to obtain a thin section with pyroxene and olivine, and analyzed a 13.4-mg chip by instrumental neutron activation analysis (INAA). The results of this analysis are briefly discussed. Author

**N93-18817*#** Geological Survey, La Jolla, CA.

**LAST CHANCE AT TAURUS-LITTROW**

D. E. Wilhelms *In* Lunar Science Inst., Workshop on Geology of the Apollo 17 Landing Site 2 Dec. 1992 p 61-63 (For primary document see N93-18786 06-91)

Avail: CASI HC A01/MF A01

By the fall of 1971, it was known that only two more Apollos would land on the Moon. Most geoscientists agreed that both should concentrate on the previously neglected terrae (highlands). In June 1991, the Apollo Site Selection Board (ASSB) had chosen Descartes as the site of the Apollo 16 terra landing, scheduled for April 1972. Therefore, we had to assess how many pre-Apollo objectives the first four landings had met, how many Apollo 16 was likely to meet, and how to meet the remaining ones with Apollo 17. Geologists convened at Caltech in November 1971 and formulated a list of major lunar problems. An edited version of the list is presented, and how the remaining problems influenced the Apollo 16 and 17 landing site selection process is discussed with particular emphasis on the selection of Taurus-Littrow as the landing site for Apollo 17. Apollo 17 returned a fine collection from the massifs, bright mantle, Sculptured Hills, subfloor basalt, and dark mantle of Taurus-Littrow. They answered many of 1971's questions, showed others to have been wrongly asked, and left others for us to ponder still today. A brief discussion of the problems solved and the questions raised by the Apollo Program are presented. Author

**N93-19801*#** Lunar and Planetary Inst., Houston, TX.

**WORKSHOP ON THE POLAR REGIONS OF MARS: GEOLOGY, GLACIOLOGY, AND CLIMATE HISTORY, PART 1**

S. M. Clifford, ed., A. D. Howard, ed., and W. S. B. Paterson, ed. 1992 36 p Workshop held in Houston, TX, 13-15 Nov. 1992; sp onsored by Lunar and Planetary Institute and the MSATT Study Group

(Contract NASw-4574)

(NASA-CR-191225; NAS 1.26:191225; LPI-TR-92-08-Pt-1) Avail: CASI HC A03/MF A01

Papers and abstract of papers presented at the workshop are presented. Some representative titles are as follows: Glaciation in Elysium; Orbital, rotational, and climatic interactions; Water on Mars; Rheology of water-silicate mixtures at low temperatures; Evolution of the Martian atmosphere (the role of polar caps); Is CO2 ice permanent; Dust transport into Martian polar latitudes; Mars observer radio science (MORS) observations in polar regions; and Wind transport near the poles of Mars (timescales of changes in deposition and erosion). For individual titles, see N93-19802 through N93-19820.

**N93-19802*#** Texas A&M Univ., College Station.

**GLACIATION IN ELYSIUM Abstract Only**

Duwayne M. Anderson *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 1 (For primary document see N93-19801 06-91)

Avail: CASI HC A01/MF A01

Results of a study of high resolution Viking Orbiter images of the northwestern slopes of Elysium Mons, using a variety of image analysis techniques, provide striking evidence of an extended period of glaciation that involved a large ice sheet of greater than 1.2 km thickness and subice fluvial activity that contributed to the formation of the channels of Hrad Valles and Granicus Valles. These two unusual channel systems begin on the lower slopes of Elysium Mons and extend into Utopia Planitia in the region lying between 215 and 230 degs W and between 25 and 45 degs N. Key indicators are the presence of serrated volcanic constructs whose dimensions and morphology indicate an origin involving successive, localized, subice fissure eruptions. The channels visible in Hrad Valles bear a striking resemblance to subice fluvial features found in the dry valleys of Antarctica at the periphery of this massive continental ice sheet. Crater size distributions and crater morphologies are quite consistent with this interpretation, as are certain other topographic features suggesting the presence in the past of ice-rich permafrost that, while having undergone significant degradation, still remains. Author

**N93-19803*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD. Geodynamics Branch.

**ORBITAL, ROTATIONAL, AND CLIMATIC INTERACTIONS: LESSONS FROM EARTH AND MARS**

Bruce G. Bills *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 1-4 (For primary document see N93-19801 06-91)

Avail: CASI HC A01/MF A01

Though variations in orbital and rotational parameters of the Earth and Mars are widely recognized as plausible sources of significant climatic variation on 10(exp 3) to 10(exp 8) yr timescales, many aspects of the connection between orbital, rotational, and climatic variations remain poorly understood. In general, the orbital histories are very well known, the rotational histories (especially for Mars) are very poorly known. A brief review is given of recent progress in computing orbital and rotational secular variations, and in connecting them to climatic change. The emphasis is on highlighting those areas that limit the present understanding. It is obvious that mass redistributions associated with climatic change (glaciation) are a source of crustal deformation and geodynamic change on the Earth, and may have played similar roles on Mars. It is much less appreciated, that rates, phases, and amplitudes of deformation of the deep interior of the planet can influence climate. The mantle and core, if decoupled, would precess at different rates, and even with plausible coupling strengths, some degree of differential precession is possible. Author

**N93-19804*#** Toledo Univ., OH. Dept. of Physics and Astronomy.

**CONDENSATION PHASE OF THE MARTIAN SOUTH POLAR CAP**

J. Capuano, M. Reed, and P. B. James *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 4-6 (For primary document see N93-19801 06-91)

Avail: CASI HC A01/MF A01

One type of database that can be useful in limiting models of the Mars surface-atmosphere system is the time dependent boundary of CO2 frost for the polar caps. Data acquired by the thermal infrared sensors on spacecraft are not limited by the lighting problems that hamper visual observations. The surface temperature of solid CO2 is limited by Clapeyron's equation as a function of the local partial pressure of CO2 gas. The growth was studied of the Martian south polar cap using the Viking IRTM dataset. These data are available in five bands, four of which should correspond to surface radiation in clear conditions; the 20 micron data was examined in the first phase. Author

**N93-19805*#** Lunar and Planetary Inst., Houston, TX.

**WATER ON MARS: INVENTORY, DISTRIBUTION, AND POSSIBLE SOURCES OF POLAR ICE**

S. M. Clifford *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 6- (For primary document see N93-19801 06-91)

Avail: CASI HC A01/MF A01

Theoretical considerations and various lines of morphologic evidence suggest that, in addition to the normal seasonal and climatic exchange of H2O that occurs between the Martian polar caps, atmosphere, and mid to high latitude regolith, large volumes of water have been introduced into the planet's long term hydrologic cycle by the sublimation of equatorial ground ice, impacts, catastrophic flooding, and volcanism. Under the climatic conditions that are thought to have prevailed on Mars throughout the past

3 to 4 b.y., much of this water is expected to have been cold trapped at the poles. The amount of polar ice contributed by each of the planet's potential crustal sources is discussed and estimated. The final analysis suggests that only 5 to 15 pct. of this potential inventory is now in residence at the poles. Author

**N93-19806*#** Lawrence Livermore National Lab., CA.
**RHEOLOGY OF WATER-SILICATE MIXTURES AT LOW TEMPERATURES Abstract Only**
William B. Durham *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 7-8 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

Lab studies of the effects of hard particulates on the rheology of ice have been mainly directed at the evolution of the Galilean satellites, but yield results that may be applicable to the rheology of the Martian polar caps. The experiments have explored the ductile rheology as well as brittle behavior of water + particulate (mainly quartz) mixtures in particulate volume fractions ranging from 0.001 to 0.56, particulate sizes 1 to 150 microns, temperatures 77 to 224 K, and deformation rates 3.5 x 10(exp -7) to 3.5 x 10(exp -4)/s, under confining pressures of 50 to 100 MPa. Particulates act mainly to strengthen the material in the ductile field, although work by others has shown that very close to the melting temperature hard particulates can actually cause softening. So called dispersion hardening by the Orowan mechanism of pinning glide dislocations, often exploited in metallurgy for strengthening materials, appears not to be an issue in ice except at very low temperatures, less than approx. 135 K. Author

**N93-19807*#** Los Alamos National Lab., NM.
**MARTIAN VOLATILES DETERMINED USING THE MARS OBSERVER GAMMA RAY SPECTROMETER Abstract Only**
W. C. Feldman (Los Alamos National Lab., NM.), W. V. Boynton (Arizona Univ., Tucson.), J. I. Trombka (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.), J. R. Arnold (California Univ., San Diego.), P. A. J. Englert (San Jose State Univ., CA.), A. E. Metzger (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), R. C. Reedy (Los Alamos National Lab., NM.), S. W. Squyres (Cornell Univ., Ithaca, NY.), and H. Wanke (Max-Planck-Inst. fuer Chemie, Mainz, Germany ) *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 8 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

The relative abundances of H2O and CO2 and their latitude, longitude, and depth profiles on Mars sensitively reflect, as well as help control, past and present Martian climate patterns. Seasonal variations of their distributions at high latitudes also reflect and help control global weather patterns and erosion through surface weathering. A combined analysis of gamma ray line and neutron flux maps constructed from data measured using the Mars Observer Gamma Ray Spectrometer (MOGRS) should allow a determination of seasonal changes in both the horizontal and vertical structure of CO2 ice that covers the north polar cap during winter and the south polar cap throughout the year and both the horizontal and vertical structure of residual H2O ice within the top meter of the surface that was predicted from Viking observations to exist primarily at high latitudes. Particularly important in this regard will be maps of thermal and epithermal neutron fluxes measured using the MOGRS anticoincidence shield, the intensity of the hydrogen, neutron capture gamma ray line at 2.223 MeV, the intensity of a capture gamma ray line as 1.725 MeV from iron, and the intensity of an inelastic scatter gamma ray line as 1.779 MeV from silicon. Author

**N93-19808*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD. Geodynamics Branch.
**DO LARGE IMPACT BASINS IN THE SOUTHERN HEMISPHERE OF MARS CONTROL THE DISTRIBUTION OF POLAR STRUCTURES AND DEPOSITS? Abstract Only**
Herbert Frey and Anne-Marie Reidy (Maryland Univ., College Park.) *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 8-10 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

Among the problems in Martian geology are the cause of the off-axis and asymmetric distribution of the southern polar layered terrain and residual ice deposits and the cause of the orientation of scarps, valleys, and reentrant canyons that occur. A problem region is the small number of large (D greater than 500) impact basins seen in the relatively well preserved cratered terrain of the south polar region. This region was mapped in detail, searching for evidence of ancient, highly degraded impact basins for two reasons: To determine whether the apparent absence of large impact basins is due to incomplete mapping and recognition or a fundamental characteristic of the Martian crust related to the origin of the Martian crustal dichotomy, and whether ancient impact basins exert some control on the distribution of volcanic and polar deposits in the Southern Hemisphere and on the topography on which these deposits lie. The possible influence is examined of the candidate basins in localizing the asymmetric distribution of polar deposits and in controlling the orientation of structures found within these deposits. Author

**N93-19809*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**EVOLUTION OF THE MARTIAN ATMOSPHERE: THE ROLE OF THE POLAR CAPS Abstract Only**
R. M. Haberle, D. Tyler, C. P. McKay, and W. Davis *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 10-11 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

Lines of evidence indicate that early in Mars' history, it had a much thicker CO2 atmosphere than it does today. A model was constructed for the evolution of the Martian atmosphere that self consistently calculates the rates at which CO2 is stored in Mars' polar reservoirs. Given some initial abundance, which is assumed to be entirely in the atmosphere, the model calculates the annually averaged temperature of the equatorial region and the polar region, and the planetwide mean. Thus far, results obtained for the case where CO2 condensation in the atmosphere is not a limiting factor. Results fall into two categories: initial inventories above 1 bar and below 1 bar. For inventories above 1 bar, CO2 is partitioned between the atmosphere and regolith with the latter taking up almost 800 mbar of CO2. The rest remains in the atmosphere and is weathered out at a rate proportional to atmospheric pressure. For values less than 1 bar, the evolution scenario is different, polar caps form immediately since there is not enough greenhouse warming to prevent CO2 from going into the regolith and thereby reducing the atmospheric pressure to levels where caps can form. The results do not favor either scenario. Author

**N93-19810*#** California Inst. of Tech., Pasadena. Geology and Planetology Section.
**THE POLAR LAYERED DEPOSITS ON MARS: INFERENCE FROM THERMAL INERTIA MODELING AND GEOLOGIC STUDIES**
K. E. Herkenhoff *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 11-13 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

It is widely believed that the Martian polar layered deposits record climate variations over at least the last 10 to 100 m.y., but the details of the processes involved and their relative roles in layer formation and evolution remain obscure. Weathering of the Martian layered deposits by sublimation of water ice can account for the thermal inertias, water vapor abundances, and geologic relationships observed in the Martian polar regions. The nonvolatile components of the layered deposits appears to consist mainly of bright red dust, with small amounts of dark dust. Dark dust, perhaps similar to the magnetic material found at the Viking Lander sites, may preferentially form filamentary residue particles upon weathering of the deposits. Once eroded, these particles may saltate to form the dark dunes found in both polar regions. This scenario for the origin and evolution of the dark material within the polar layered deposits is consistent with the available imaging and thermal data. Further experimental measurements of the thermophysical properties of magnetite and maghemite under Martian conditions are needed to better test this hypothesis. Author

**N93-19811*#** Colorado Univ., Boulder. Lab. for Atmospheric and Space Physics.
**THE MARS WATER CYCLE AT OTHER EPOCHS: RECENT HISTORY OF THE POLAR CAPS AND LAYERED TERRAIN Abstract Only**
Bruce M. Jakosky, Bradley G. Henderson, and Michael T. Mellon *In its*

Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 13 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

The Martian polar caps and layered terrain presumably evolves by the deposition and removal of small amounts of water and dust each year, the current cap attributes therefore represent the incremental transport during a single year as integrated over long periods of time. The role was studied of condensation and sublimation of water ice in this process by examining the seasonal water cycle during the last 10(exp 7) yr. In the model, axial obliquity, eccentricity, and L sub s of perihelion vary according to dynamical models. At each epoch, the seasonal variations in temperature are calculated at the two poles, keeping track of the seasonal CO2 cap and the summertime sublimation of water vapor into the atmosphere; net exchange of water between the two caps is calculated based on the difference in the summertime sublimation between the two caps (or on the sublimation from one cap if the other is covered with CO2 frost all year). Results from the model can help to explain (1) the apparent inconsistency between the timescales inferred for layer formation and the much older crater retention age of the cap and (2) the difference in sizes of the two residual caps, with the south being smaller than the north. Author

**N93-19812*#** Geological Survey, Flagstaff, AZ.
**POSSIBLE RECENT AND ANCIENT GLACIAL ICE FLOW IN THE SOUTH POLAR REGION OF MARS**
J. S. Kargel *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 13-16 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

Martian polar science began almost as soon as small telescopes were trained on the planet. The seasonal expansion and contraction of the polar caps and their high albedoes led most astronomers to think that water ice is the dominant constituent. In 1911 Lowell perceived a bluish band around the retreating edge of the polar caps, and interpreted it as water from melting polar ice and seasonal snow. An alternative idea in his time was that the polar caps consist of frozen carbonic acid. Lowell rejected the carbonic acid hypothesis on account of his blue band. He also pointed out that carbonic acid would sublimate rather than melt at confining pressures near and below one bar, hence, carbonic acid could not account for the blue band. In comparing Lowell's theories with today's knowledge, it is recognized that (1) sublimation is mainly responsible for the growth and contraction of Mars' polar caps, (2) carbon dioxide is a major component of the southern polar cap, and (3) Lowell's blue band was probably seasonal dust and/or clouds. Geomorphic evidence that glacial ice and glacial melt waters once flowed over broad areas of the southern polar region. Two aspects of the south polar region suggest possible glacial processes during two distinct eras in Mars' history. Author

**N93-19813*#** Atmospheric and Environmental Research, Inc., Cambridge, MA.
**IS CO2 ICE PERMANENT?**
Bernhard Lee Lindner *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 16-17 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

Carbon dioxide ice has been inferred to exist at the south pole in summertime, but Earth based measurements in 1969 of water vapor in the Martian atmosphere suggest that all CO2 ice sublined from the southern polar cap and exposed underlying water ice. This implies that the observed summertime CO2 ice is of recent origin. It appears possible to construct an energy balance model that maintains seasonal CO2 ice at the south pole year round and still reasonably simulates the polar cap regression and atmospheric pressure data. This implies that the CO2 ice observed in the summertime south polar cap could be seasonal in origin, and that minor changes in climate could cause CO2 ice to completely vanish, as would appear to have happened in 1969. However, further research remains before it is certain whether the CO2 ice observed in the summertime south polar cap is seasonal or is part of a permanent reservoir. Author

**N93-19814*#** Lowell Observatory, Flagstaff, AZ.
**THE INTERANNUAL VARIABILITY OF POLAR CAP RECESSIONS AS A MEASURE OF MARTIAN CLIMATE AND WEATHER: USING EARTH-BASED DATA TO AUGMENT THE TIME LINE FOR THE MARS OBSERVER MAPPING MISSION**
L. J. Martin and P. B. James (Lowell Observatory, Flagstaff, AZ.) *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 17-18 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

The recessions of the polar ice caps are the most visible and most studied indication of seasonal change on Mars. Circumstantial evidence links these recessions to the seasonal cycles of CO2, water, and dust. The possible advent of a planet encircling storm during the Mars Observer (MO) mission will provide a detailed correlation with a cap recession for that one Martian year. That cap recession will then be compared with other storm and nonstorm years. MO data will also provide a stronger link between cap recessions and the water and CO2 cycles. Cap recession variability might also be used to determine the variability of these cycles. After nearly a century of valiant attempts at measuring polar cap recessions, including Mariner 9 and Viking data, MO will provide the first comprehensive dataset. In contrast to MO, the older data are much less detailed and precise and could be forgotten, except that it will still be the only information on interannual variability. By obtaining simultaneous Earth-based observations (including those from Hubble) during the MO mission, direct comparisons can be made between the datasets. Author

**N93-19815*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**DUST TRANSPORT INTO MARTIAN POLAR LATITUDES**
J. R. Murphy and J. B. Pollack *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 18-19 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

The presence of suspended dust in the Martian atmosphere, and its return to the planet's surface, is implicated in the formation of the polar layered terrain and the dichotomy in perennial CO2 polar cap retention in the two hemispheres. A three dimensional model was used to study Martian global dust storms. The model accounts for the interactive feedbacks between the atmospheric thermal and dynamical states and an evolving radiatively active suspended dust load. Results from dust storm experiments, as well as from simulations in which there is interest in identifying the conditions under which surface dust lifting occurs at various locations and times, indicate that dust transport due to atmospheric eddy motions is likely to be important in the arrival of suspended dust at polar latitudes. The layered terrain in both polar regions of Mars is interpreted as the reality of cyclical episodes of volatile (CO2, H2O) and dust deposition.
Author

**N93-19816*#** Virginia Univ., Charlottesville. Dept. of Atmospheric Science.
**NUMERICAL SIMULATIONS OF DRAINAGE FLOWS ON MARS**
Thomas R. Parish and Alan D. Howard *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 19-23 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

Data collected by Viking Landers have shown that the meteorology of the near surface Martian environment is analogous to desertlike terrestrial conditions. Geological evidence such as dunes and frost streaks indicate that the surface wind is a potentially important factor in scouring of the martian landscape. In particular, the north polar basin shows erosional features that suggest katabatic wind convergence into broad valleys near the margin of the polar cap. The pattern of katabatic wind drainage off the north polar cap is similar to that observed on Earth over Antarctica or Greenland. The sensitivity is explored of Martian drainage flows to variations in terrain slope and diurnal heating using a numerical modeling approach. The model used is a 2-D sigma coordinate primitive equation system that has been used for simulations of Antarctic drainage flows. Prognostic equations include the flux forms of the horizontal scalar momentum equations, temperature, and continuity. Parameterization of both longwave (terrestrial) and shortwave (solar) radiation is included. Turbulent transfer

of heat and momentum in the Martian atmosphere remains uncertain since relevant measurements are essentially nonexistent. Author

**N93-19817*#** Geological Survey, Flagstaff, AZ. Astrogeology Branch.
**ANTARCTIC LAKES (ABOVE AND BENEATH THE ICE SHEET): ANALOGUES FOR MARS**
J. W. Rice, Jr. *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 23-26 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

The perennial ice covered lakes of the Antarctic are considered to be excellent analogues to lakes that once existed on Mars. Field studies of ice covered lakes, paleolakes, and polar beaches were conducted in the Bunger Hills Oasis, Eastern Antarctica. These studies are extended to the Dry Valleys, Western Antarctica, and the Arctic. Important distinctions were made between ice covered and non-ice covered bodies of water in terms of the geomorphic signatures produced. The most notable landforms produced by ice covered lakes are ice shoved ridges. These features form discrete segmented ramparts of boulders and sediments pushed up along the shores of lakes and/or seas. Sub-ice lakes have been discovered under the Antarctic ice sheet using radio echo sounding. These lakes occur in regions of low surface slope, low surface accumulations, and low ice velocity, and occupy bedrock hollows. The presence of sub-ice lakes below the Martian polar caps is possible. The discovery of the Antarctic sub-ice lakes raises possibilities concerning Martian lakes and exobiology. Author

**N93-19818*#** Stanford Univ., CA. Center for Radar Astronomy.
**MARS OBSERVER RADIO SCIENCE (MORS) OBSERVATIONS IN POLAR REGIONS**
Richard A. Simpson *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 24-26 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

MORS observations will focus on two major areas of study: (1) the gravity field of Mars and its interpretation in terms of internal structure and history and (2) the structure of the atmosphere, with emphasis on both temperature-pressure profiles of the background atmosphere and small scale inhomogeneities resulting from turbulence. Scattering of cm wavelength radio signals from Mars' surface at highly oblique angles will also be studied during the primary mission; nongrazing scattering experiments may be possible during an extended mission. During the MORS primary mission, measurements of the spacecraft distance and velocity with respect to Earth based tracking stations will be used to develop models of the global gravity field. The improvement in knowledge of the gravity field will be especially evident in polar regions. The spatial and temporal coverage of atmospheric radio occultation measurements are determined by the geometry of the spacecraft orbit and the direction to the Earth. Profiles of atmospheric temperature and pressure will extend from the surface to altitudes of 50 to 70 km. Author

**N93-19819*#** Cornell Univ., Ithaca, NY. Center for Radiophysics and Space Research.
**WIND TRANSPORT NEAR THE POLES OF MARS: TIMESCALES OF CHANGES IN DEPOSITION AND EROSION Abstract Only**
Peter C. Thomas *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 26 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

Movement of sediment into and out of polar deposits is closely linked to the polar volatile budget and to changes in wind systems over the course of astronomically induced climate cycles. The present observations of the morphology of polar layered deposits, mantling sediments, dune fields, and variable surface features are the basis of inferences on the efficacy of polar sediment transport mechanisms. The time scales of formation of these features vary from days to perhaps 10(exp 6) yr, and latitudinal banding of dune fields near the poles may have been formed on timescales of 10(exp 7) yr. Orientations of intracrater dunes, dune crests, and wind streaks have been measured for latitudes -45 to -90 to compare features of likely different timescales of formation with models of wind flow from the south polar region. There is a complex variation with latitude of the indicated wind directions and of the efficacy of the resultant winds in orienting dune fields that suggests influence of frost cover on the ability of winds to move sediment in the spring and fall. Because of changes in the relative effectiveness of spring and fall winds expected with progression of the season of perihelion, the latitudinal variation in transport efficiency may mean that sediments at different latitudes dominantly respond to wind erosion and transport at different times during the perihelion cycle. Author

**N93-19820*#** California Univ., Los Angeles. Dept. of Earth and Space Sciences.
**MODELING INTERANNUAL VARIABILITY IN THE MARTIAN SEASONAL CO2 CYCLE**
S. E. Wood and D. A. Paige *In its* Workshop on the Polar Regions of Mars: Geology, Glaciology, and Climate History, Part 1 1992 p 26-30 (For primary document see N93-19801 06-91)
Avail: CASI HC A01/MF A01

One aspect of the seasonal pressure variations measured at the Viking Lander sites is their nearly perfect interannual repeatability. This presents a problem because it implies that the behavior of the seasonal polar caps should be highly repeatable from year to year as well. There are a number of observations and theories suggesting that the presence of dust and water ice clouds in the Martian atmosphere should have significant direct and indirect effects on the rates of CO2 condensation and sublimation in the north and south polar regions. These effects include (1) reduced rates of CO2 frost condensation during polar night seasons due to the radiative effects of dust and water ice clouds and associated CO2 clouds or elevated atmospheric temperatures and (2) reduced or elevated rates of frost sublimation due to the radiative effects of atmospheric dust or to changes in frost emissivities and albedos due to contamination by water ice and dust. The Viking Landing pressure observations are examined to determine the range and character of the interannual variations present. Then a diurnal and seasonal thermal model is used to examine the effects of interannual variations in the polar heat balance on seasonal pressure variations. Author

**N93-18557*#** California Inst. of Tech., Pasadena. Div. of Geology and Planetary Sciences.
**MARS OBSERVER: MISSION TOWARD A BASIC UNDERSTANDING OF MARS**
Arden L. Albee *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 199-214 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

**N93-18559*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**CASSINI: MISSION TO SATURN AND TITAN**
Stuart J. Kerridge (California Univ., Los Angeles.), Walter Flury (European Space Agency. European Space Operations Center, Darmstadt, Germany), Linda J. Horn (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), Jean-Pierre LeBreton (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ), Douglas S. Stetson, Richard L. Stoller, and Grace H. Tan *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 229-248 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

**N93-18560*#** Geological Survey, Menlo Park, CA.
**MRSR: RATIONALE FOR A MARS ROVER/SAMPLE RETURN MISSION**
Michael H. Carr *In* NASA. Ames Research Center, Exobiology in Solar System Exploration Aug. 1992 p 249-262 Original contains color illustrations (For primary document see N93-18545 06-51)
Avail: CASI HC A03/MF A03; 46 functional color pages

# 92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots. For related information see *93 Space Radiation.*

**N93-17922#** California Inst. of Tech., Pasadena. Solar Astronomy Group.

**LARGE-SCALE VELOCITY FIELDS AND SMALL-SCALE MAGNETIC FIELDS DURING THE MAXIMUM OF SOLAR CYCLE 22 Annual Technical Report, 1 Oct. 1990 - 30 Sep. 1991**

Sara F. Martin and K. L. Harvey Nov. 1992 22 p

(Grant AF-AFOSR-0006-90)

(AD-A258172; AFOSR-92-0966TR) Avail: CASI HC A03/MF A01

One key accomplishment from the research during FY 1991 was the finding by K. Harvey and P. Foukal that the photospheric network is the third significant component that accounts for observed variations in the total solar irradiance (the first previously recognized component is the temporary decreases due to sunspots and the second is variation due to plage brightness). Other key accomplishments were the K. Harvey results from studying magnetic flux over the solar cycle: (1) increases in the total magnetic flux by a factor of 4 to 5 from solar minimum to solar maximum with the variation from active regions flux (greater than 25 Gauss) by more than a factor of 20 from cycle minimum to maximum while the variation from quiet sun fields (less than 25 Gauss) was no more than a factor of 2; (2) interpretation of (1) as meaning that more than 70 percent of the magnetic flux in active regions disappears without dispersing; (3) slower decreases of weak fields in phase with the decrease in strong fields; and (4) irregular pulses of new flux which appear to be primarily associated with active region complexes. GRA

**N93-18334#** Phillips Lab., Hanscom AFB, MA.

**PHOTOELECTRIC ANALYSIS OF THE SOLAR GRANULATION IN IR**

Serge Koutchmy 12 Nov. 1992 4 p

(AD-A257811; PL-TR-92-2294) Avail: CASI HC A01/MF A01

Results of both image analysis and statistical analysis of 1D scans the IR granulation observed in the opacity minimum region are briefly presented. The same technique was applied at 600 nm and results partially presented by Koutchmy and Lebecq, 1986, Astron. Astrophys. 169, 323. All observations were collected at the prime focus of the Sac Peak VTT using high signal-to-noise ratio measurements with a specially-designed pinhole PbS spectro-photometer; imaging has been made using both 2D scanning of the telescope and processed video-scans of an IR-vidicon. Images of the IR granulation and of sunspot umbral dots and penumbral filaments are present for the first time. GRA

**N93-18577*#** Alabama Univ., Huntsville. Dept. of Mechanical Engineering and Center for Space Plasma and Aeronomic Research.

**A STUDY OF PHYSICAL MECHANISMS FOR FILAMENT ERUPTION AND CORONAL MASS EJECTION VIA NUMERICAL SIMULATION Progress Report, 1 Jan. - Jun. 1991**

S. T. Wu Jun. 1991 50 p

(Grant NAGw-9)

(NASA-CR-192118; NAS 1.26:192118) Avail: CASI HC A03/MF A01

It is well-known from both observation and theory that photospheric shear motion has played a key role in physical processes of the energy build-up and release for the solar flare. In order to further our understanding of the occurrence of solar flares it is necessary to investigate the triggering mechanism. One popular scenario for the onset of eruptive solar flares is that in response to photospheric shear motions the magnetic field evolves slowly through a series of magnetohydrodynamic-equilibria until a threshold is reached where magnetohydrodynamic (MHD) non-equilibrium sets in. Thus, a magnetic eruption occurs, causing the solar flare. To substantiate this claim we have employed our newly developed three-dimensional time-dependent MHD code with gravity to simulate the evolution of the coronal field. We use plasma beta = 0.1 to closely approximate the condition in the actual corona. Some preliminary results are presented. Author

**N93-18780*#** Utah State Univ., Logan. Center for Atmospheric and Space Sciences.

**THE FLOW OF PLASMA IN THE SOLAR TERRESTRIAL ENVIRONMENT Semiannual Technical Report, 1 Apr. - 30 Sep. 1992**

R. W. Schunk 1992 17 p

(Grant NAG5-1484)

(NASA-CR-192106; NAS 1.26:192106) Avail: CASI HC A03/MF A01

The overall goal of our NASA Theory Program is to study the coupling, time delays, and feedback mechanisms between the various regions of the solar-terrestrial system in a self-consistent, quantitative manner. To accomplish this goal, it will eventually be necessary to have time-dependent macroscopic models of the different regions of the solar-terrestrial system and we are continually working toward this goal. However, our immediate emphasis is on the near-earth plasma environment, including the ionosphere, the plasmasphere, and the polar wind. In this area, we have developed unique global models that allow us to study the coupling between the different regions. Another important aspect of our NASA Theory Program concerns the effect that localized structure has on the macroscopic flow in the ionosphere, plasmasphere, thermosphere, and polar wind. The localized structure can be created by structured magnetospheric inputs (i.e., structured plasma convection, particle precipitation or Birkeland current patterns) or time variations in these inputs due to storms and substorms. Also, some of the plasma flows that we predict with our macroscopic models may be unstable, and another one of our goals is to examine the stability of our predicted flows. Because time-dependent, three-dimensional numerical models of the solar-terrestrial environment generally require extensive computer resources, they are usually based on relatively simple mathematical formulations (i.e., simple MHD or hydrodynamic formulation). Therefore, another long-range goal of our NASA Theory Program is to study the conditions under which various mathematical formulations can be applied to specific solar-terrestrial regions. This may involve a detailed comparison of kinetic, semikinetic, and hydrodynamic predictions for a given polar wind scenario or it may involve the comparison of a small-scale particle-in-cell (PIC) simulation of a plasma expansion event with a similar macroscopic expansion event. The different mathematical formulations have different strengths and weaknesses and a careful comparison of model predictions for similar geophysical situations will provide insight into when the various models can be used with confidence. Author

**N93-18869*#** Science Applications International Corp., San Diego, CA.

**DETERMINATION OF CORONAL MAGNETIC FIELDS FROM VECTOR MAGNETOGRAMS Semiannual Progress Report, 30 Jun. - 31 Dec. 1992**

Zoran Mikic 31 Dec. 1992 33 p Original contains color illustrations

(Contract NASw-4728)

(NASA-CR-191386; NAS 1.26:191386) Avail: CASI HC A03/MF A01; 4 functional color pages

The determination of coronal magnetic fields from vector magnetograms, including the development and application of algorithms to determine force-free coronal fields above selected observations of active regions is studied. Two additional active regions were selected and analyzed. The restriction of periodicity in the 3-D code which is used to determine the coronal field was removed giving the new code variable mesh spacing and is thus able to provide a more realistic description of coronal fields. The NOAA active region AR5747 of 20 Oct. 1989 was studied. A brief account of progress during the research performed is reported. Author

**N93-18880*#** Michigan Univ., Ann Arbor. Dept. of Atmospheric, Oceanic and Space Sciences.

**SOLAR EXTREME ULTRAVIOLET SENSOR AND ADVANCED LANGMUIR PROBE Progress Report**

N. R. Voronka, B. P. Block, and G. R. Carignan 14 Dec. 1992 80 p

(Grant NAG5-1619)

(NASA-CR-191972; NAS 1.26:191972) Avail: CASI HC A05/MF A01

For more than two decades, the staff of the Space Physics Research Laboratory (SPRL) has collaborated with the Goddard Space Flight Center (GSFC) in the design and implementation of Langmuir probes (LP). This program of probe development under the direction of Larry Brace of GSFC has evolved methodically with innovations to: improve measurement precision, increase the speed of measurement, and reduce the weight, size, power consumption and data rate of the instrument. Under contract NAG5-419 these improvements were implemented and are what characterize the Advanced Langmuir Probe (ALP). Using data from the Langmuir Probe on the Pioneer Venus Orbiter, Brace and Walter Hoegy of GSFC demonstrated a novel method of monitoring the solar extreme ultraviolet (EUV) flux. This led to the idea of developing a sensor similar to a

Langmuir probe specifically designed to measure solar EUV (SEUV) that uses a similar electronics package. Under this contract, a combined instrument package of the ALP and SEUV sensor was to be designed, constructed, and laboratory tested. Finally the instrument was to be flight tested as part of sounding rocket experiment to acquire the necessary data to validate this method for possible use in future earth and planetary aeronomy missions. The primary purpose of this contract was to develop the electronics hardware and software for this instrument, since the actual sensors were suppied by GSFC. Due to budget constraints, only a flight model was constructed. These electronics were tested and calibrated in the laboratory, and then the instrument was integrated into the rocket payload at Wallops Flight Facility where it underwent environmental testing. After instrument recalibration at SPRL, the payload was reintegrated and launched from the Poker Flat Research Range near Fairbanks Alaska. The payload was successfully recovered and after refurbishment underwent further testing and developing to improve its performance for future use.
Author

**N93-19650*#** Lockheed Missiles and Space Co., Palo Alto, CA. Research Lab.
**A SOLAR MAGNETIC AND VELOCITY FIELD MEASUREMENT SYSTEM FOR SPACELAB 2: THE SOLAR OPTICAL UNIVERSAL POLARIMETER (SOUP) Final Report, Sep. 1977 - Jan. 1991**
Theodore D. Tarbell and Alan M. Title Aug. 1992 56 p
(Contract NAS8-32805)
(NASA-CR-191443; NAS 1.26:191443; LMSC/F404726) Avail: CASI HC A04/MF A01

The Solar Optical Universal Polarimeter flew on the Shuttle Mission Spacelab 2 (STS-51F) in August, 1985, and collected historic solar observations. SOUP is the only solar telescope on either a spacecraft or balloon which has delivered long sequences of diffraction-limited images. These movies led to several discoveries about the solar atmosphere which were published in the scientific journals. After Spacelab 2, reflights were planned on the Space Shuttle Sunlab Mission, which was cancelled after the Challenger disaster, and on balloon flights, which were also cancelled for funding reasons. In the meantime, the instrument was used in a productive program of ground-based observing, which collected excellent scientific data and served as instrument tests. This report gives an overview of the history of the SOUP program, the scientific discoveries, and the instrument design and performance.
Author

**N93-19932*#** New Hampshire Univ., Durham. Inst. for the Study of Earth, Oceans, and Space.
**THEORETICAL STUDIES ON THE CHROMOSPHERE, CORONA, AND SOLAR WIND Final Report, Jun. 1980 - Dec. 1990**
Joseph V. Hollweg and Martin A. Lee Dec. 1990 10 p
(Grant NAGw-76)
(NASA-CR-192116; NAS 1.26:192116) Avail: CASI HC A02/MF A01

Papers published during the period from Jun. 1980 - Dec. 1990 are listed.
L.R.R.

**N93-18072*#** Tasmania Univ., Hobart (Australia). Physics Dept.
**THE SOLAR WIND STRUCTURES ASSOCIATED WITH COSMIC RAY DECREASES AND PARTICLE ACCELERATION IN 1978-1982**
H. V. Cane, I. G. Richardson (Maryland Univ., College Park.), and T. T. VonRosenvinge (Maryland Univ., College Park.) *In* Universities Space Research Association, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 10 Dec. 1992 26 p (For primary document see N93-18070 06-43)
Avail: CASI HC A03/MF A03

**N93-19190*#** Southwest Research Inst., San Antonio, TX.
**DISTURBANCES OF BOTH COMETARY AND EARTH'S MAGNETOSPHERES EXCITED BY SINGLE SOLAR FLARES**
I. Konno, T. Saito (Tohoku Univ., Sendai, Japan ), Y. Kozuka (Tohoku Univ., Sendai, Japan ), K. Nishioka (Olympus Optical Co. Ltd., Tokyo, Japan ), M. Saito (Saito Astronomical Observatory, Japan ), and T. Takahashi (Tohoku Univ., Sendai, Japan ) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 321-324 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19192*#** Tohoku Univ., Sendai (Japan). Geophysical Inst.
**THE SOLAR WIND STRUCTURE THAT CAUSED A LARGE-SCALE DISTURBANCE OF THE PLASMA TAIL OF COMET AUSTIN**
Yukio Kozuka, Ichishiro Konno (Southwest Research Inst., San Antonio, TX.), Takao Saito, and Shigemi Numazawa (Japan Planetarium Lab.) *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 329-332 (For primary document see N93-19113 06-90)
Avail: CASI HC A01/MF A04

**N93-19266*#** University of Southern California, Los Angeles. Space Sciences Center.
**VELOCITY DISTRIBUTIONS OF H AND OH PRODUCED THROUGH SOLAR PHOTODISSOCIATION OF H2O**
C. Y. Robert Wu, F. Z. Chen, and D. L. Judge *In* Lunar and Planetary Inst., Asteroids, Comets, Meteors 1991 1992 p 657-660 (For primary document see N93-19113 06-90)
(Grants NAGw-1924; NSF ATM-87-22482; NSF DMR-88-21625)
Avail: CASI HC A01/MF A04

**N93-19521#** Technische Univ., Brunswick (Germany). Inst. fuer Geophysik und Meteorologie.
**OBSERVATIONAL EVIDENCE FOR FIELD-ALIGNED POTENTIAL DROPS AT VERY LOW ALTITUDES ASSOCIATED WITH TRAVELLING CONVECTION VORTICES Abstract Only**
H. Luehr, W. Blawert, and H. Todd (University of the South Pacific, Suva, Fiji ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19542#** EISCAT Scientific Association, Ramfjordbotn (Norway).
**SOLAR WIND VELOCITY MEASUREMENTS WITH THE EISCAT UHF ANTENNA ARRAY Abstract Only**
U. P. Loevhaug, William A. Coles (California Univ., San Diego.), R. Esser (Tromsoe Univ., Norway ), and J. Markkanen (EISCAT Scientific Association, Sodankylae, Finland ) *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

**N93-19556#** Geophysical Observatory, Sodankyla (Finland).
**POLAR CAP ABSORPTION EVENTS OBSERVED DURING THE EISCAT OPERATION IN 1981-1989 Abstract Only**
Hilkka Ranta and Aarne Ranta *In* Oulu Univ., Fifth EISCAT Scientific Workshop: Programme and Abstracts 1991 1 p (For primary document see N93-19518 06-90)
Avail: CASI HC A01/MF A01

## 93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

**N93-17878#** Rome Univ. (Italy). Dipt. di Fisica.
**COSMIC-RAY NM-64 NEUTRON MONITOR DATA-19 FROM ROME, ITALY Annual Report, Jan - Dec. 1990**
N. Iucci, E. Re (Consiglio Nazionale delle Ricerche, Frascati, Italy ), F. Signoretto (Consiglio Nazionale delle Ricerche, Frascati, Italy ), C. Signorini (Consiglio Nazionale delle Ricerche, Frascati, Italy ), G. Villoresi (Consiglio Nazionale delle Ricerche, Frascati, Italy ), and N. L. Zangrilli (Consiglio Nazionale delle Ricerche, Frascati, Italy ) 3 Dec. 1991 67 p
(Nota-Interna-989; ETN-93-93353) Avail: CASI HC A04/MF A01

Pressure corrected data from the Rome (Italy) neutron monitor and barometric pressure data are given in tabular form for the year 1990. The graphs of the corrected intensity are also given. Details of the devices employed, the operational mode, and data handling are given. Additionally, the following topics are discussed: the monitor, atmospheric pressure measurement, data acquisition system, stability, efficiency changes, barometric correction, presentation of the data, references, relevant

particulars, normalization factors, pressure corrected rates and section ratios, barometric pressure, and normalized graphs. ESA

**N93-18014*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**EFFECTS OF RADIOBIOLOGICAL UNCERTAINTY ON SHIELD DESIGN FOR A 60-DAY LUNAR MISSION**
John W. Wilson, John E. Nealy, and Walter Schimmerling (Universities Space Research Association, Washington, DC.) Washington Feb. 1993 10 p
(RTOP 199-04-16-11)
(NASA-TM-4422; L-17136; NAS 1.15:4422) Avail: CASI HC A02/MF A01

Some consequences of uncertainties in radiobiological risk due to galactic cosmic ray exposure are analyzed to determine their effect on engineering designs for a first lunar outpost - a 60-day mission. Quantitative estimates of shield mass requirements as a function of a radiobiological uncertainty factor are given for a simplified vehicle structure. The additional shield mass required for compensation is calculated as a function of the uncertainty in galactic cosmic ray exposure, and this mass is found to be as large as a factor of 3 for a lunar transfer vehicle. The additional cost resulting from this mass is also calculated. These cost estimates are then used to exemplify the cost-effectiveness of research. Author

**N93-18583*#** Mississippi State Univ., Mississippi State. Dept. of Physics.
**AN ANALYSIS OF THE STRUCTURE OF GAMMA RAY BURST TIME HISTORIES**
John Patrick Lestrade, G. J. Fishman (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.), C. A. Meegan (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.), R.B. Wilson (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.), W. S. Paciesas (Alabama Univ., Huntsville.), G. N. Pendleton (Alabama Univ., Huntsville.), P. Moore (Boeing Computer Support Services, Inc., Huntsville, AL.), and H. E. Cody (National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.) [1992] 5 p
(Grant NAG8-212)
(NASA-CR-191997; NAS 1.26:191997) Avail: CASI HC A01/MF A01

If gamma-ray bursts (GRB) arise from a small number of distinctly different physical phenomena, then this might be revealed by a clustering of time profile characteristics into a small number of groups. A 'spike' counting algorithm was applied to 107 GRB profiles. Graphs of spike frequency and spike amplitude versus burst intensity and duration are presented. So far, no evidence of grouping is seen. Author

**N93-19109*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**MARS SURFACE RADIATION EXPOSURE FOR SOLAR MAXIMUM CONDITIONS AND 1989 SOLAR PROTON EVENTS**
Lisa C. Simonsen and John E. Nealy Washington Feb. 1992 16 p
(RTOP 593-42-31-01)
(NASA-TP-3300; L-17152; NAS 1.60:3300) Avail: CASI HC A03/MF A01

The Langley heavy-ion/nucleon transport code, HZETRN, and the high-energy nucleon transport code, BRYNTRN, are used to predict the propagation of galactic cosmic rays (GCR's) and solar flare protons through the carbon dioxide atmosphere of Mars. Particle fluences and the resulting doses are estimated on the surface of Mars for GCR's during solar maximum conditions and the Aug., Sep., and Oct. 1989 solar proton events. These results extend previously calculated surface estimates for GCR's at solar minimum conditions and the Feb. 1956, Nov. 1960, and Aug. 1972 solar proton events. Surface doses are estimated with both a low-density and a high-density carbon dioxide model of the atmosphere for altitudes of 0, 4, 8, and 12 km above the surface. A solar modulation function is incorporated to estimate the GCR dose variation between solar minimum and maximum conditions over the 11-year solar cycle. By using current Mars mission scenarios, doses to the skin, eye, and blood-forming organs are predicted for short- and long-duration stay times on the Martian surface throughout the solar cycle. Author

**N93-19383** Minnesota Univ., Minneapolis.
**A COSMIC RAY PROPAGATION MODEL Ph.D. Thesis**
Robert Russell Clinton 1992 117 p
Avail: Univ. Microfilms Order No. DA9233978

This work describes a stepwise program of interstellar cosmic ray propagation that is used to study the sensitivity of propagation models of ultra heavy cosmic ray nuclei (UH nuclei). We have evaluated the uncertainties introduced in the predicted abundances by calculating the fragmentation cross sections using different procedures, by varying the input energy, and by varying the escape length of the cosmic ray nuclei. These uncertainties have been compared with the predicted differences introduced by assuming that the source abundances resemble either solar system, pure r-, or pure s-process material. These comparisons allow us to determine how the uncertainties in the above mentioned parameters affect the abundances of the cosmic ray nuclei. We conclude that the uncertainties in nuclear cross sections presently prevent us from drawing any but the broadest conclusions from the measured abundances.
Dissert. Abstr.

**N93-19384** Utah Univ., Salt Lake City.
**DEEPLY PENETRATING EVENTS IN THE EXTREMELY HIGH-ENERGY COSMIC RAY FLUX Ph.D. Thesis**
Bruce L. Emerson 1992 108 p
Avail: Univ. Microfilms Order No. DA9236272

This dissertation will present the results of a search for deeply penetrating particles in the Extremely High Energy (EHE) (particle energy greater than or equal to 10(exp 17) eV) cosmic ray flux. The data are from the University of Utah Fly's Eye detector which is a unique detector for observing cosmic rays in this energy regime. Central to this search is the definition of a robust signature for deeply penetrating Extensive Air Showers (EAS) which is given as follows: Candidate deeply penetrating events are those whose plane normal angle (theta(sub n)) is less than 18 degrees. The absence of events in the Fly's Eye data set meeting this criterion is examined in the context of models of astrophysical neutrino flux and charm production at EHE energies. The use of the calculations in this dissertation to test other models for the production of deeply penetrating extensive air showers is described where needed. Dissert. Abstr.

**N93-18071*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD. Lab. for High Energy Astrophysics.
**COSMIC RAY DECREASES AND MAGNETIC CLOUDS**
H. V. Cane *In* Universities Space Research Association, Goddard Visiting Scientist Program for the Space and Earth Sciences Directorate 10 Dec. 1992 12 p (For primary document see N93-18070 06-43)
Avail: CASI HC A03/MF A03

**N93-18909*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**CORRELATED FLUX DENSITIES FROM VLBI OBSERVATIONS WITH THE DSN**
R. F. Coker *In its* The Telecommunications and Data Acquisition 15 Nov. 1992 p 118-128 (For primary document see N93-18897 06-32)
(RTOP 314-30-41-11-31)
Avail: CASI HC A03/MF A03

## 99 GENERAL

**N93-17854#** National Science Foundation, Washington, DC.
**EHR DIRECTORY OF AWARDS, FY 1990**
1991 624 p
(NSF-92-75) Avail: CASI HC A99/MF A06

This volume is the detailed record of the awards made during Fiscal Year 1990 by the National Science Foundation's Directorate for Education and Human Resources (EHR). NSF's education activities continue to grow at a rapid rate, and, in order to retain a single volume format, the record will be reported somewhat differently in the future. The introductory sections of this volume take the first step toward different content and character.
Author

**N93-17890#** Air War Coll., Maxwell AFB, AL.
**DR. ALEXANDER H. FLAX: TECHNOLOGIST OF AERONAUTICS**
Legand L. Burge Mar. 1992 58 p
(AD-A258441) Avail: CASI HC A04/MF A01

This paper is a tribute to the unique contribution of Dr. Alexander H. Flax who served from 1963 to 1969 as Assistant Secretary for Research and Development, US Air Force. A number of pioneering efforts concerning aircraft flight have affected the Air Force. Since its beginning great innovators have emerged who improved upon the art and science of flight. One such person is Al Flax. This article identifies, describes, and assesses Flax's contributions to the field of aeronautics and to the United States Air Force's science and technology program. The study is based on open sources, research, and oral history interviews regarding Flax's life. Air power and the control of the battlefield offered by airborne equipment and personnel owe much to Flax's work. Flax contributed to decisive elements of aerospace power, aerodynamics and aeronautics. Rotorcraft, wide-body aircraft, aircraft materials, and spacecraft. GRA

**N93-18175#** Naval Training Systems Center, Orlando, FL.
**RESEARCH AND DEVELOPMENT PROJECT SUMMARIES Annual Report, Oct. 1992**
Bobbie Petersen Oct. 1992 74 p
(AD-A257518; NTSC-93-01) Avail: CASI HC A04/MF A01

This brochure presents brief summaries of the FY93 research efforts at the Naval Training Systems Center (NAVTRASYSCEN) in Orlando, FL. NAVTRASYSCEN has comprehensive simulation and training systems responsibilities ranging from research and technology base development through system acquisition and life cycle support. The NAVTRASYSCEN is unique in this integrated role because it performs research, specifies the training device's engineering, instructional, and operational requirements, selects the contractor, evaluates the trainer as it is being built, and ensures the trainer can be properly operated and maintained in the field. In addition to the Navy, NAVTRASYSCEN provides services for the Marine Corps, Army, Air Force, and foreign governments. The NAVTRASYSCEN's research mission is to plan and perform a full range of directed research and development in support of Naval training systems for all warfare areas and platforms, to maintain an expanding technology base, and to transition research results to the fleet. Research and development program emphasis is on fleet and training command requirements, rapid transition of products, industry/university coordination, improved planning, coordination with other services, and improved quality and cost effectiveness of products. GRA

**N93-18459#** Aerospace Corp., El Segundo, CA.
**AEROSPACE SPONSORED RESEARCH Progress Report, 1 Oct. 1990 - 30 Sep. 1991**
1 Dec. 1991 167 p
(ATR-91(8498)-1) Avail: CASI HC A08/MF A02

The structure and mission of The Aerospace Corporation's research and development program is coordinated with, and complementary to, that of the Air Force laboratories and other organizations actively working in space-system-related technology. This report presents brief summaries of the results and progress achieved by the Aerospace Sponsored Research program during the period 1 Oct. 1990 through 30 Sep. 1991. The following areas are discussed: electronics and optics; materials properties and processing; space and atmospheric environment; space communication and navigation; surveillance from space; spacecraft and launch vehicle design and operation; spacecraft survivability; and systems architecture, planning, and analysis. For individual titles, see N93-18460 through N93-18506.

**N93-18460#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**ACOUSTO-OPTIC FREQUENCY EXCISION** **c33**
M. J. OLoughlin, D. G. Heflinger, W. E. Yamada, D. C. Mayer, and R. S. Boughton *In its* Aerospace Sponsored Research 1 Dec. 1991 p 5-7 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

We have designed an adaptive photodetector and have simulated its theoretical performance for acousto-optic frequency excision. Utilizing the computer-modeled photodetector design, a set of photolithographic plates was designed and purchased. GaAs epitaxial crystal layers were grown by molecular-beam epitaxy and fabricated into photodetectors, which were characterized in a testbed and exhibited excellent adaptive behavior. A refined photodetector, featuring an antireflection coating, is currently being fabricated. Author

**N93-18461#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**DEVICE APPLICATIONS OF LAYERED STRUCTURES** **c33**
R. C. Lacoe, W. L. Bloss, M. J. OLoughlin, D. A. Gutierrez, and R. C. Cole *In its* Aerospace Sponsored Research 1 Dec. 1991 p 8-11 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The objective of this project is to explore the application of layered semiconductor structures fabricated by molecular-beam epitaxy (MBE) to the development of electronic and electro-optical devices of interest for space applications. The principal focus of this project was the development of high-performance long-wavelength infrared (LWIR) photodetectors comprising multiple quantum wells formed by alternating layers of gallium arsenide (GaAs) and aluminum gallium arsenide (AlGaAs). Previously, we successfully modeled, designed, fabricated, and characterized quantum-well infrared photodetectors (QWIPs) with high detectivities. In the just-completed year, we investigated further the physics responsible for limiting the performance of these devices, explored new structures to enhance device performance, and designed, fabricated, and characterized QWIPs with peak responsivity at wavelengths longer than 10 microns. Author

**N93-18462#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**VLSI MICROELECTRONICS RESEARCH** **c33**
D. C. Mayer, D. L. Leung, and R. C. Cole *In its* Aerospace Sponsored Research 1 Dec. 1991 p 11-14 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The performance advantages of ultra-thin silicon-on-insulator (SOI) make it especially attractive for space applications, but the sensitivity of the back silicon/oxide interface to interface state generation will degrade the radiation hardness of the metal oxide semiconductor field effect transistors (MOSFET's). The two reported experimental techniques for extracting the distribution of back interface states from observed drain current-gate-source-voltage characteristics of fully depleted SOI MOSFET's as the substrate voltage is varied, result in similar extracted values for D(sub itb) as a function of bandgap energy for fully depleted n-and p-MOSFETs. Using these techniques, the radiation hardness of the back SOI interface can be assessed for space applications. Author

**N93-18463#** Aerospace Corp., El Segundo, CA. Electronics and Sensors Div.
**NONLINEAR CIRCUITS AND COMPONENTS** **c33**
C. P. Silva *In its* Aerospace Sponsored Research 1 Dec. 1991 p 14-17 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The purpose of this continuing project is to develop state-of-the-art analysis tools for the CAD of nonlinear microwave circuits; specifically, it comprises two principal development tasks, one for analytical methods and one for solid-state-device models. The objectives of the first task are to evaluate currently available methods for the relative merit of their algorithmic characteristics, to develop new methods and numerical algorithms to redress deficiencies identified by this evaluation, and to optimize the computer implementation of these analytical approaches. The basic goal of the second task is to develop complete and accurate solid-state device models to be used in CAD, in particular, to model the large-signal behavior and phase noise of recently introduced device families that are finding increasing use, such as high-electron-mobility transistors (HEMTs) and heterojunction bipolar transistors (HBTs). Author

**N93-18464#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**HIGH-TEMPERATURE SUPERCONDUCTING ELECTRONICS** **c33**
R. C. Lacoe, J. P. Wendt, D. A. Gutierrez, and J. P. Hurrell *In its* Aerospace Sponsored Research 1 Dec. 1991 p 18-21 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

We have grown high-quality YBCO high temperature superconducting

(HTS) thin films by pulsed laser ablation from a stoichiometric target and have determined the optimal substrate temperature, oxygen pressure, and laser power density to deposit films with transition temperatures of 89 K and transition widths of 0.5 K. We continued our investigation into the noise properties of HTS thin films by establishing a collaboration with Sandia National Laboratories to investigate the noise in single- and dual-phase Tl-Ba-Ca-Cu-O (TBCCO) thin films. The excess noise in the presence of a bias current is dominated by 1/f noise, and the presence of a peak or peaks in the noise power density at the foot of the superconducting transition is directly related to the number of superconducting phases. The anomalous behavior in the 1/f noise exponent can be described by a model in which that noise originates from random fluctuations associated with an activated process. We hypothesized that, for HTS films, the activated process is the depinning of magnetic vortices. Author

**N93-18465#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**NOVEL INTERCONNECT DEPOSITION TECHNOLOGY** **c33**

D. M. Speckman and J. P. Wendt *In its* Aerospace Sponsored Research 1 Dec. 1991 p 21-23 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

A new series of experiments was initiated to improve current interconnect deposition technology for integrated circuits. Preliminary aluminum deposition experiments were carried out using trimethylamine(alane) as the precursor, and some mildly reflective, uniform aluminum films were successfully deposited on glass slides, suggesting that chemical vapor deposition (CVD) will be a practicable deposition technique for advanced integrated circuit interconnect films. CVD studies of aluminum and zirconium- and hafnium-diboride thin films are continuing. Author

**N93-18466#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**INFRARED PHOTOLUMINESCENCE SPECTROSCOPY** **c25**

P. A. Dafesh, R. P. Wright, and C. J. Selvey *In its* Aerospace Sponsored Research 1 Dec. 1991 p 24-26 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

We have completed the design of a cryogenic infrared photoluminescence (PL) spectrometer incorporating a new long wavelength infrared (LWIR) photon-counting detector (SSPM) with cold (T = 4K) optics. The photon-counting operation of the SSPM, used in this spectrometer, was confirmed by studying variation in pulse height distribution with temperature and bias in a reduced-background environment. To facilitate future photoluminescence research studies, we established relationships with institutions growing advanced infrared materials, developed the analytic tools to explain measured-PL transitions in superlattices and multiple quantum wells, and verified the accuracy of these tools in predicting the photoreflectance transition energies measured in those structures. In the coming year, we expect to complete construction of our spectrometer, write the computer code for controlling the scanning mechanism, and begin to take and analyze PL spectra from existing LWIR surveillance sensor materials. Author

**N93-18467#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**NANORECORDING** **c35**

G. Eng, N. A. Ives, B. A. Morgan, and M. S. Leung *In its* Aerospace Sponsored Research 1 Dec. 1991 p 26-28 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

We conducted preliminary studies to determine whether a high-energy, high-current-density beam from the scanning tunneling microscope (STM) tip could modify an uncoated graphite surface. Using voltage pulses, we successfully wrote reproducible single dots on graphite. Those dots were roughly circular, with diameters smaller than approximately 300 A. We were able to produce linear features by scanning the tip along a line while applying voltage pulses at regular intervals. The resulting line has a width of only approximately 100 A. Because the STM was digitally stepped between the voltage pulses, the line was not uniform, but had features that are consistent with an etching process or physical ablation of material by the STM electron beam. This etching process, which is the inverse of a beam-induced deposition process, can also be used for recording information on a nanometer scale. Author

**N93-18468#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**ADVANCED ATOMIC FILTERS** **c74**

J. A. Gelbwachs and Y. C. Chan *In its* Aerospace Sponsored Research 1 Dec. 1991 p 31-34 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

We investigated the operation of a new, passive Fraunhofer-wavelength atomic filter well suited for underwater laser systems. The filter exhibits a 50 micro-s decay time and a single noise passband. Conversion efficiencies up to 45 percent and an adjustable optical bandwidth were demonstrated. The adjustable bandwidth is particularly useful for spacecraft applications. The demonstrated performance, combined with the simplicity of operation, strongly suggests that the passive strontium filter will gain wide acceptance in the atmospheric and ocean optics community. Author

**N93-18469#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**HIGH-ENERGY LASER-PARTICLE INTERACTION** **c36**

D. W. Pack *In its* Aerospace Sponsored Research 1 Dec. 1991 p 34-39 (For primary document see N93-18459 06-99)

Avail: CASI HC A02/MF A02

This project investigates the spectral signatures associated with high-energy laser-particle interactions. Our main research objective is to improve predictive modeling of laser interaction with atmospheric particles by systematically studying the emissions from atmospheric aerosols interacting with high-energy lasers as a function of laser wavelength and intensity. Development of the theoretical formalism to interpret the results is an important part of this effort. The samples that are being analyzed mimic atmospheric particles: droplets of water and water soluble salts, ammonium and calcium sulfates, and microsamples of sand and carbon. This year, our theoretical work emphasized the optics of cloud-sized water droplets, and experiments were conducted to detail the power dependence of the two strongest nonlinear signals: stimulated Raman scattering (SRS) and breakdown-induced plasma emission. Author

**N93-18470#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**TRANSITION DYNAMICS AND GUEST-HOST INTERACTIONS IN LASER MATERIALS** **c36**

T. S. Rose *In its* Aerospace Sponsored Research 1 Dec. 1991 p 40-43 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

The work this year sought to examine relevant issues concerning two laser materials, neodymium-doped yttrium aluminum garnet (Nd:YAG) and Cr:Forsterite, which are potential sources for future compact all-solid-state devices for applications in remote sensing and communications. In Nd:YAG, nonequivalent crystal field sites were observed and their effects on laser performance are being evaluated. In Cr:Forsterite, a tunable solid-state material, experiments are under way to identify the active laser ion that produces the tunable laser output in the 1.1-1.3 micron range. The laser emission is believed to result from a new tetravalent chromium center. Study of this system will increase our knowledge of chromium ion centers, which not only provide laser emission but are also responsible for radiation hardening of certain laser crystals, an issue pertinent to space-based laser systems. Author

**N93-18471#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**STIMULATED BRILLOUIN SCATTERING PHASE CONJUGATION** **c74**

S. T. Amimoto and R. F. W. Gross *In its* Aerospace Sponsored Research 1 Dec. 1991 p 43-46 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

The goal of this project is to investigate ultrasensitive coherent detectors (USCD's) for surveillance applications. Two areas of research were proposed, and they are described in order of priority. The first is the study and characterization of a laboratory benchtop USCD using stannic chloride ($SnCl_4$) as the Brillouin medium. A Brillouin medium is a gas or liquid that,

under the influence of an intense beam of light, forms acoustic or density waves characterized by a spatial wavelength of one-half the optical wavelength and capable of causing scattering of an optical beam. A USCD is a combination of neodymium-doped yttrium aluminum garnet (Nd:YAG) amplifiers with a four-wave Brillouin mirror (FWBM). The FWBM consists of a cell containing the nonlinear Brillouin material into which three beams are overlapped in space and time; a return beam is produced and is detected. Methods to evaluate SnCl4 as the Brillouin medium will be developed. The second area of research is an investigation of the single-pass correction of aberrations (SPICA) methods of correcting images or aberrations. Holographic methods of implementing such corrections are well known; we propose to replace the holograms (photographic plates) with the FWBM to create real-time correction. This work will be reported next year. Author

**N93-18472#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**NOVEL SHORT-WAVELENGTH LASERS** **c36**

J. M. Herbelin *In its* Aerospace Sponsored Research 1 Dec. 1991 p 46-48 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The nitrogen fluoride/pumped bismuth monofluoride, NF(a)/BiF(A0(+)), reaction system continues to be investigated as a power source for a supersonic visible (blue) laser. Such a laser would capitalize on the many advantages of supersonic flow that have been successfully demonstrated by the familiar hydrogen fluoride/deuterium fluoride (HF/DF) infrared-emitting lasers and would take advantage of the beam propagation characteristic, i.e., reduced divergence of the beam, of shorter wavelengths. Recent experiments conducted in the pulse facility at the Rockwell Science Center have demonstrated gain on the blue electronic transition; and very recently, lasing in a supersonic flow was demonstrated. This year's efforts focused on analytical and experimental studies to determine the optimal injection scheme to produce the desired lasing. Described here is development of the supersonic nozzle-injection scheme that led to the successful demonstration. Author

**N93-18473#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**TUNABLE INFRARED AND VISIBLE SOLID-STATE LASER** **c36**

D. Chen *In its* Aerospace Sponsored Research 1 Dec. 1991 p 48-50 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

We developed a capability for measuring the optical properties of nonlinear materials using a solid-state laser and demonstrated a continuously tunable light source over a wide range of wavelengths in the ultraviolet, visible, and near infrared. In demonstrating the second-harmonic generation capability, confidence was increased in the feasibility of the concept of constructing a space-qualified tunable laser using nonlinear optical processes. The preliminary optical measurements of the lithium barium triorbate (LBO) crystal indicate its usefulness for ultraviolet and visible wavelength conversion. Next year, project focus will be on SFG and DFG studies using the nonlinear crystals LBO, LiIO3, and silver gallium sulfide (AgGaS2). Author

**N93-18474#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**INFRARED SENSOR TECHNOLOGY AND APPLICATIONS** **c74**

R. W. Russell and G. S. Arnold *In its* Aerospace Sponsored Research 1 Dec. 1991 p 51-53 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

We constructed and tested a molecular beam facility for the direct, mass spectrometric measurement of the products of gas-solid reactions and their velocities. To examine one mode of vibrational excitation in gas-solid collisions--inelastic scattering from inert surfaces--we designed, constructed, and installed a supersonic nozzle source that can be heated to between 700 and 800 C. Initial experiments to measure the velocity distribution of carbon dioxide (CO2) scattered from lithium fluoride (LiF) indicated that product detection will require single-ion counting detection. The CO2 + LiF experiments will be completed next year, and the surface mediated reactions of atomic oxygen, atomic nitrogen, and nitrogen oxides that can produce NO will be examined to help interpret SKIRT results. Author

**N93-18475#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**PICOSECOND STUDIES OF SPACE OPTICAL MATERIALS** **c74**

S. C. Moss *In its* Aerospace Sponsored Research 1 Dec. 1991 p 53-56 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

We have developed powerful picosecond transient photoreflectance techniques for nondestructive evaluation of the thermo-optical properties of crystalline and amorphous materials commonly used in space satellite systems. The techniques also yield information about the effects of commonly used processing steps, such as ion implantation and thermal annealing, on the thermo-optical properties of such materials. Author

**N93-18476#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**INDIUM PHOSPHIDE PHOTOVOLTAIC TECHNOLOGY** **c44**

L. F. Halle and D. C. Marvin *In its* Aerospace Sponsored Research 1 Dec. 1991 p 56-59 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

Indium phosphide (InP) solar cells are an alternative to silicon or gallium arsenide solar cells for spacecraft that accumulate high doses of radiation during missions, because they appear to be more resistant to radiation damage than Si or GaAs, and the damage that is incurred can be partially annealed at low temperatures. The InP cells will undergo some annealing during each orbit; therefore, whether the defect sites initially present upon irradiation continue to be the dominant factors in cell degradation after multiple cycles must be ascertained. The goals of this project were to examine the mechanism of irradiation damage and annealing in InP material, and to determine whether one or more mechanisms were dominant over many irradiation and anneal cycles. Author

**N93-18477#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**RADIATION PROPERTIES OF HIGH-TEMPERATURE FLAMES** **c25**

A. T. Pritt, Jr. *In its* Aerospace Sponsored Research 1 Dec. 1991 p 63-65 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

A facility for generating high temperature flames at low pressures in a continuously flowing tube was constructed. Moderate-resolution flame emission spectra were collected, and we demonstrated that flames can be generated at temperatures in excess of approximately 1500 K. Author

**N93-18478#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**CHARACTERIZATION OF RADIATION DAMAGE IN SOLIDS** **c72**

R. A. Fields and T. S. Rose *In its* Aerospace Sponsored Research 1 Dec. 1991 p 66-68 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

To determine how the formation of color centers degrades performance, a series of spectroscopic experiments to measure electron paramagnetic resonance (EPR) absorption, transmission, and threshold were performed before and after irradiation. Low-temperature EPR spectra of three Nd:YAG samples taken after exposure to 600-krad Co-60 gamma radiation revealed no change in the Nd(3+) signal, but clearly revealed the presence of paramagnetic color centers, results that agree with those of previous studies. The absorption measurements at the pump wavelength indicated that, for given input intensities, approximately the same amount of pump light was absorbed. Consistent with the EPR data, this result indicated that there was no alteration in the local Nd(3+) environment, and hence no change in the Nd(3+) energy-level structure. Furthermore, earlier work demonstrated that absorption resulting from color-center formation was fairly negligible compared with the Nd(3+) absorption in the wavelength region of the laser-diode pump (800 nm). However, whether color centers cause nonradiative depopulation of the excited Nd(3+) sites was not established. Author

**N93-18479#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**MECHANISM OF DIAMOND FILM GROWTH** **c76**

L. R. Martin *In its* Aerospace Sponsored Research 1 Dec. 1991 p 69-70 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The current technologies for diamond formation involve chemically and physically complex systems of many species, very high temperatures, and steep gradients in temperature and in concentration. Such complexity makes it difficult to identify the scientific phenomena responsible for the formation of diamonds and, therefore, difficult to engineer improvements in the new technology. The long-range development of diamond films will require a better understanding of those phenomena. The objective of our research is to improve the scientific knowledge of the diamond-growth mechanism by achieving the simplest possible chemical and physical conditions for diamond growth. This approach makes it easier to interpret experiments, and lends itself to computer modeling. This year, our initial identification of the mechanism was confirmed by five different groups in the U.S. and Japan.

Author

**N93-18480#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**FLOW VISUALIZATION AND COMBUSTION DIAGNOSTIC** **c25**

E. J. Beiting *In its* Aerospace Sponsored Research 1 Dec. 1991 p 70-73 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

The objective of this project is to develop a fast, two dimensional flow visualization diagnostic for investigating nonreacting and reacting turbulent flows at atmospheric pressure. Using multiangular absorption and tomographic computer algorithms to reconstruct a cross section of the flow, the diagnostic will have sufficient temporal and spatial resolution both to freeze and to identify turbulent structures and to measure concentration and temperature.

Author

**N93-18481#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**FLAME-FRONT KINETICS** **c25**

T. A. Spiglanin, E. W. Fournier, J. A. Syage, and R. B. Cohen *In its* Aerospace Sponsored Research 1 Dec. 1991 p 73-76 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

Many launch vehicles, including the Space Shuttle and the developing National Launch System, are equipped with a hydrogen/oxygen propulsion system that requires an external ignition source. Upper stages such as Centaur carry their own ignition mechanism to remotely start their hydrogen/oxygen motors. Often overlooked, but critical to Air Force space missions, is launch-site fire safety. The Air Force offices of Safety, Bioastronautical Engineering, and Environmental Planning have complementary responsibilities for identifying launch-site ignition hazards. With an increasing focus on the environmental safety of fire-suppression systems, a detailed understanding of spark ignition is essential to developing the new fire-safety systems that are required by federal law. To support these various Air Force programs, this project has as its principal objective establishment of the early-time behavior and microscopic details of the chemistry that leads to ignition. We focus primarily on spark ignition because it is the form of flame initiation that can be applied most generally to Air Force missions. We have sought to characterize the chemical kinetics of ignition, flame propagation, and combustion inhibition on the basis of time-resolved species identification and energy distributions in propagating flame fronts.

Author

**N93-18482#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**PROPULSION DIAGNOSTICS** **c20**

S. W. Janson, M. W. Crofton, R. P. Welle, and R. B. Cohen *In its* Aerospace Sponsored Research 1 Dec. 1991 p 76-79 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

The objective of this project is to develop diagnostic techniques for microscopically characterizing thruster plume species, velocity, and state-resolved V(sub i), E(sub i), v(sub i), j(sub i) distributions. Such techniques will provide a scientific and engineering understanding of the operation of chemical and electrical thrusters, leading to the development of thrusters with improved performance and reliability, and reduced contamination potential. They will also enable performance and contamination codes to be validated and improved with a minimum of ground test time, thereby accelerating thruster development, and reducing research and development costs and spacecraft integration testing.

Author

**N93-18483#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**PICOSECOND MOLECULAR-BEAM STUDIES OF CHEMICAL REACTIVITY** **c72**

J. A. Syage and J. Steadman *In its* Aerospace Sponsored Research 1 Dec. 1991 p 79-82 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

The study of time-resolved properties of clusters this year emphasized characterization of the mechanisms by which the structure of matter on a molecular level influences chemical reactivity. Very pronounced transitions in chemical reactivity were observed at the single-molecule level. In the coming year, the cluster effort will focus on atmospheric and environmental issues. The success of our efforts in the last two years places us at the forefront of time-resolved measurements of cluster dynamics. Furthermore, this project has led to the development of new technologies that are now being applied to Space Systems Division-related programs, such as laser ignition of fuels, fluorescence detection of thruster devices, and resonance ionization for trace environmental detection. The data and results of our research have also provided essential information to plume signature chemistry, combustion chemistry, contamination effects, and atmospheric phenomena.

Author

**N93-18484#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**KINETICS AND INFRARED SPECTROSCOPY OF ORGANOMETALLIC REACTIVE INTERMEDIATES** **c25**

B. H. Weiller *In its* Aerospace Sponsored Research 1 Dec. 1991 p 82-86 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

The objective of this project is to examine by infrared spectroscopy the detailed chemistry underlying organometallic chemical vapor deposition (OMCVD) of thin-film materials. In OMCVD, an organometallic compound is decomposed at a relatively low temperature to form a high-melting thin-film material. For example, pure films of tungsten, a highly refractory metal with a melting point in excess of 3000 C, can be formed by decomposition of gaseous tungsten carbonyl at 200 C. It is a powerful and routinely used method for producing a wide range of thin-film materials, including metals, dielectrics, ceramics, and semiconductors that have space applications ranging from solar cells and novel optical filters to high-temperature protective coatings for rocket motors. OMCVD allows temperature-sensitive substrates to be coated and is the best way to achieve complete coverage of complex topographies, such as those found in integrated circuits.

Author

**N93-18485#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**MICROSTRUCTURAL CONTROL OF COMPLEX ALLOYS** **c26**

C. C. Wan *In its* Aerospace Sponsored Research 1 Dec. 1991 p 86-90 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

We used the rapid solidification rate (RSR) melt-spinning technique in an argon atmosphere, and successfully produced chemically homogeneous Y-Ba-Cu-Ag metallic precursors in ribbon form. To convert the metallic precursor to a superconducting Ag/YBa2Cu3O7 composite ribbon without distortion, we developed a low-temperature, 450-550 C, oxidation treatment in pure oxygen and a high-temperature, 850 C, annealing process in air. The annealed ribbon revealed an interwoven microstructure consisting of a pure-Ag phase and a needlelike oxide phase; both phases appeared to be continuous. The oxide phase was further identified by x-ray diffraction to be the YBa2Cu3O7 superconducting oxide. Resistance measurement indicated a T(sub c) at about 84 K and zero resistance at about 69 K. Additional tests are being conducted to study the oxidation kinetics of the precursor material in order to raise the T(sub c) while maintaining the mechanical integrity of the superconducting ribbon.

Author

**N93-18486#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.

**NONLINEAR ACOUSTIC-ELECTROMAGNETIC COUPLING IN MATERIALS** **c24**

G. F. Hawkins and P. M. Sheaffer *In its* Aerospace Sponsored Research 1 Dec. 1991 p 90-92 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The goal of this project is to describe the basic physical mechanisms that produce nonlinear coupling between acoustic and electromagnetic fields in various piezoelectric and magnetostrictive materials. The nonlinear effects of these materials can be exploited in acoustomagnetic embedded-sensor applications to overcome such fundamental shortcomings of linear technologies as the inability to measure absolute stresses. To determine the coefficients for the quadratic and higher order terms in the Taylor expansion of the coupling response, nonlinear coupling is investigated as a function of applied stress, magnetic induction, electric field, and temperature. Materials in which these coefficients display a strong dependence on the applied acoustic and electromagnetic fields are given particular attention. The resulting information will be used to investigate the enhancement of desirable nonlinear effects in those materials to maximize their efficiency as embedded sensors. Author

**N93-18487#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
**MOLECULAR-SCALE HYBRID POLYMER CERAMICS** **c27**
T. W. Giants *In its* Aerospace Sponsored Research 1 Dec. 1991 p 92-94 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The overall objective of this investigation is to synthesize thermally stable organic monomers and polymers capable of coreacting with inorganic components through the sol-gel process to provide access to hybrid polymer-ceramic structures not otherwise easily obtained. The goal of this project is to understand how molecular network structure affects composite properties and apply this knowledge to the construction of advanced materials for future Space Systems Division application. The initial phase of this work comprised two tasks. The first task was to prepare a new organic precursor material, and the second task was to develop the sol-gel processing conditions for producing hybrid materials both as thin films and in bulk. Concurrent with the preparative task, two commercially available organic precursors were selected as substitute coreactants with the inorganic precursor, tetraethoxysilane (TEOS), in the processing task. Author

**N93-18488#** Aerospace Corp., El Segundo, CA. Mechanics and Materials Technology Center.
**EXPERIMENTAL AND THEORETICAL STUDIES OF THE STRUCTURE OF METAL DICHALCOGENIDES** **c26**
J. R. Lince and T. B. Stewart *In its* Aerospace Sponsored Research 1 Dec. 1991 p 94-96 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

Thin solid films of transition-metal dichalcogenide (TMD) compounds, such as molybdenum disulfide (MoS2) and niobium selenide (NbSe2), are used as lubricating and antiwear coatings in space systems. The friction and wear properties of these films are determined by the structural properties of the films--crystallinity and bond lengths--which are, in turn, determined by the electronic structure within the TMDs. This project combines theoretical calculations with experimental measurements of the atomic and electronic structures of TMDs. Currently, we are substituting different elements, for example, selenium (Se), silver (Ag), and niobium (Nb), into the TMD crystal lattice. Such substitution allows us to examine the effect of solid solution formation and metal doping on the atomic and electronic structures to learn ways of controlling the lubricity and conductivity of TMD compounds. Our goal, ultimately, is to predict the compositions that will optimize the tribological properties and conductivity of TMD-based solid lubricants for such space-oriented applications as sliding electrical contacts, latches, sensor gimbals, and cryogenic assemblies. Author

**N93-18489#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**NANOTECHNOLOGY** **c76**
D. W. Pack and A. B. Pluchino *In its* Aerospace Sponsored Research 1 Dec. 1991 p 96-98 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

This is an experimental project to study the physics of matter with nanometer dimensions. Its specific goal is to make the first laser measurements on single, isolated particles between 1 and 500 nm in size. The measurements can be used to guide and test theories on quantum sized effects and other deviations from the properties of bulk matter. Samples for study include metals, semiconductors, and soot particles. This year we conducted experiments to measure thermal properties of isolated particles while improving our experimental apparatus. In order to study individual particles we designed and constructed a new type of levitator for trapping and isolating nanometer-sized particles. Author

**N93-18490#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**SCANNING TUNNELING MICROSCOPE STUDIES OF NICKEL OXYHYDROXIDES** **c76**
A. H. Zimmerman and M. V. Quinzio *In its* Aerospace Sponsored Research 1 Dec. 1991 p 99-101 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The scanning tunneling microscope (STM) enables the structure of solid surfaces to be examined routinely at atomic resolution. In recent years, the STM has come into wide use for directly imaging the atomic and molecular structures of many crystalline surfaces. The purpose of this project is to use the unique capabilities of the STM, in conjunction with high-precision electrochemical measurements, to identify the mechanisms by which the local electronic and lattice structures of nickel oxyhydroxides control the fabrication of nickel hydrogen battery cells. Instabilities in the structure and composition of oxyhydroxide materials are a major life-limiting factor in those cells. Author

**N93-18491#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.
**CHAOTIC DYNAMICS OF ATOMS** **c72**
J. C. Camparo and R. P. Frueholz *In its* Aerospace Sponsored Research 1 Dec. 1991 p 101-105 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

Our work in space program technology this year was in support of a rubidium atomic clock that Milstar is developing for its satellites. In support of efforts to reduce an unacceptable temperature sensitivity in the Milstar clock, we employed our theoretical model of atomic dynamics in fluctuating fields to evaluate the phase delay introduced into a clock's frequency control feedback loop by the atomic system. Author

**N93-18492#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.
**ENERGY STORAGE IN SUPERCRITICAL SOLVENTS** **c28**
N. Presser *In its* Aerospace Sponsored Research 1 Dec. 1991 p 105-107 (For primary document see N93-18459 06-99)
Avail: CASI HC A01/MF A02

The objective of this three-year project is to investigate techniques for the efficient production of metal-in-matrix fuels. Our approach depends on the selection and treatment of precursors that are expected to yield large quantities of free metal atoms. Here, 'treatment' may refer to simply dissolving the precursor in a solvent. This might be true for precursors that are nanometer sized particles. 'Treatment' may also refer to a more complex process, like photochemical decomposition, if the precursor is a dissolved metal-bearing organometallic molecule. In both treatments, the solvents are supercritical gases. Supercritical gases are gases at pressures exceeding their critical pressure and at temperatures at which the application of an external pressure alone will not cause them to liquefy. They posses unique solvating properties, originally identified in 1879 by Hannay and Hogarth. Their solvating potential was subsequently quantified, most notably with the studies of Smits on the diethylether/anthraquinone system and van Niewenberg and van Zon on the solubility of quartz in supercritical water. These gases are being applied in several chemical-process industries, their role in shale oil extraction being the most prominent. Their unique solvating characteristics motivated us to select supercritical gases as solvents for preparing metal-in-matrix fuels. These gases should be able to disperse sufficient precursor to produce the required metal-atom dispersion, and subsequently stabilize the resulting dispersed metal atoms by preventing their aggregation to the bulk. Author

**N93-18493#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**STUDIES OF METAL-SEMICONDUCTOR CLUSTERS** **c76**

S. M. Beck *In its* Aerospace Sponsored Research 1 Dec. 1991 p 107-110 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

For the present benzene cluster experiments, we used the same supersonic cluster-beam apparatus as that for the previous work on silicon. We modified the apparatus substantially to develop the following technique as a universal source for producing cold cluster ions of any size organic molecule. A high-power laser-induced plasma generates cluster ions in the throat of a supersonic nozzle. The laser pulse is focused onto a metal surface, and the plasma ionizes benzene molecules seeded in a helium carrier gas. Expansion of the gas through the nozzle cools the benzene, and the clusters grow by accretion of neutral benzene molecules onto a molecular ion seed. The clusters continue to cool as the expansion proceeds, producing an intense beam of cold benzene cluster cations ranging in size from the dimer to about B(sub z(sub 20))(+). After the cluster ions exit the nozzle, they are separated by mass, and a single cluster size is selected for study using electric fields. The mass-selected beam is then intersected by the output of a tunable-frequency laser. If the light is of the correct frequency to be absorbed by the cluster, it fragments the cluster. The charged fragments are collected, mass-analyzed, and detected to produce a photofragmentation spectrum. The signals are collected in a difference mode, and the spectrum is displayed as the difference between the signal acquired with the fragmentation laser on and off. The spectra exhibit two types of peaks: positive peaks representing charged species produced by the fragmentation process, and negative peaks indicating destruction of parent-ion species. Author

**N93-18494#** Aerospace Corp., El Segundo, CA. Electronics Technology Center.

**SPIN EFFECTS IN ELECTRON-ATOM COLLISIONS** **c72**

B. Jaduszliwer and Y. C. Chan *In its* Aerospace Sponsored Research 1 Dec. 1991 p 110-113 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

This year development was completed of new technologies to prepare an atomic cesium beam in a well-defined spin state and to detect the spin state of the atom after a collision with an electron. We measured electron-cesium-atom total cross sections over a wide energy range. We are currently measuring spin dependent cross sections; this effort will be completed next year, ending the project. The apparatus built for this project was also used to investigate optical state preparation and state-dependent detection techniques currently being considered for advanced cesium-beam atomic clocks, of interest for such satellite systems as Milstar and GPS. Author

**N93-18495#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**ATMOSPHERIC DYNAMICS AND COUPLING** **c46**

R. L. Walterscheid, L. R. Lyons, M. N. Ross, and G. Schubert *In its* Aerospace Sponsored Research 1 Dec. 1991 p 117-119 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

This project is a component of a long-standing program of research into the dynamics and structure of the upper atmosphere. The various projects in the program have emphasized different areas of upper atmospheric research. The objective of the research is to characterize phenomena and processes that relate to the natural environment affecting Air Force and Space Systems Division systems; more specifically, dynamic processes in the upper atmosphere and mechanisms that couple the upper and lower atmospheres, and the ionosphere and atmosphere. The current project emphasizes processes relating to the specification and characterization of neutral density, electron density, and radiation backgrounds. Author

**N93-18496#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**AERONOMY OF AURORAL AND AIRGLOW EMISSIONS** **c46**

J. H. Hecht and L. K. Johnson *In its* Aerospace Sponsored Research 1 Dec. 1991 p 119-123 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

This research project involves obtaining field and laboratory measurements for quantitative information with which to describe basic aeronomic phenomena and processes pertaining to Air Force missions and capabilities. During previous research, we developed a Fabry-Perot interferometer system that can measure weak auroral and airglow emissions. Using this system, we showed that, by measuring auroral emissions, the adequacy of an atmospheric model for predicting the atomic oxygen density could be determined. We also measured weak OH Meinel airglow emissions and demonstrated their application to study the propagation of gravity waves through the mesopause region. We improved on that technique by developing a charge coupled device (CCD) camera system that can take pictures of both the OH Meinel emission, which occurs near 85 km, and the O2 Atmospheric band emission, which occurs near 94 km. Measurements of both emissions simultaneously will enable vertical propagation of atmospheric gravity waves to be characterized. Author

**N93-18497#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**INFRARED STUDIES OF STAR-FORMING REGIONS** **c89**

J. A. Hackwell, L. M. Friesen, D. K. Lynch, and R. W. Russell *In its* Aerospace Sponsored Research 1 Dec. 1991 p 123-125 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

Infrared light can penetrate the dense clouds of gas and dust that are present in the galactic plane; consequently, the appearance of the infrared sky is significantly different from that at visible wavelengths. Visible-light measurements are therefore useless for predicting the appearance of the infrared sky with any fidelity. Thus, space surveillance programs requiring knowledge of the infrared celestial background need direct infrared measurements at the wavelengths of interest. The purpose of this project is to identify the structure of the infrared sky at a wide range of spatial scales. Our work has concentrated on producing two new sources of information: measurements made at higher spatial resolutions than is possible with data from the Infrared Astronomical Satellite (IRAS); and information at spatial scales that is not available in previously published maps. The goal of this multiyear effort was to ascertain the physical phenomena that produce the spatial and spectral structure seen in the infrared sky. This information can then be used to predict the background that might be seen by a given infrared sensor that is attempting to locate targets against the infrared sky or to see celestial objects for calibration. Author

**N93-18498#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**IONOSPHERIC PROCESSES** **c46**

F. T. Djuth *In its* Aerospace Sponsored Research 1 Dec. 1991 p 125-129 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

We applied existing radar techniques to studies of a dynamically changing ionosphere to investigate their limitations. New radar observing strategies were formulated to improve range resolution and thereby reduce undesirable effects caused by the mixing of backscatter spectra within a single range cell. As part of a new initiative to develop improved observing methods that will significantly enhance our ability to monitor electron-temperature and -density changes in the auroral environment, we made high-resolution observations with the European Incoherent Scatter Radar Facility located near Tromso, Norway, as a testbed. Author

**N93-18499#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**AURORAL ENERGIZATION AND GEOMAGNETIC DISTURBANCES** **c46**

L. R. Lyons, M. Schulz, and J. F. Fennell *In its* Aerospace Sponsored Research 1 Dec. 1991 p 129-132 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

Significant progress was made during this year to model the physics of the transfer of solar-wind energy to the Earth's magnetosphere. The transfer of energy and plasma across the boundary between open and closed magnetic field lines was measured, and the process was elucidated. The injection of particles into the region of the stormtime ring current was also charted, which should lead, in the near future, to a model of ring current formation. Author

**N93-18500#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**TRENDS IN MIDDLE-ATMOSPHERE OZONE** **c45**

M. N. Ross *In its* Aerospace Sponsored Research 1 Dec. 1991 p 133-134 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

The goal of this study was to use pre-existing data to quantify the depletion of stratospheric ozone caused by global pollution associated with CFC's and the more local effects associated with solid rocket motor exhaust. In each case we were able to place limits on the amount of ozone loss and so contribute to the body of understanding of this process. Author

**N93-18501#** Aerospace Corp., El Segundo, CA. Space and Environment Technology Center.

**SOLAR-TERRESTRIAL PHYSICS AND ASTROPHYSICS** **c90**

R. J. Rudy, J. B. Blake, M. C. McNab, M. Schulz, and D. L. McKenzie *In its* Aerospace Sponsored Research 1 Dec. 1991 p 134-137 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

This project encompasses an evolving series of small-scale data-analysis and theoretical studies of the conditions, constituents, and physical processes in space, and the solar-terrestrial physics of the influence of the sun on the Earth and near-Earth environment. The common objective of this multifaceted research is to characterize the space environment so that the ambient background of particles and electromagnetic radiation that influence space sensor performance can be determined. The project is sufficiently flexible that the investigators can take advantage of unexpected research opportunities within the overall framework of studies of the space environment. This year, the following research topics were addressed: (1) geomagnetic trapping of the anomalous component of cosmic rays; (2) the galactic magnetosphere; (3) the formation of emission features, particularly those of the iron cation Fe(+) in planetary nebulae and emission-line stars; (4) the Fe(+17) spectrum of the sun; and (5) solar abundances. Author

**N93-18502#** Aerospace Corp., El Segundo, CA. Electronics and Sensors Div.

**ARTIFICIAL NEURAL NETWORKS APPLICATION SIMULATOR** **c63**

R. J. Talbot, T. C. Le, R. P. Ma, K. Tsai, W. C. Krenz, and H. S. Gobreial *In its* Aerospace Sponsored Research 1 Dec. 1991 p 141-146 (For primary document see N93-18459 06-99)

Avail: CASI HC A02/MF A02

Advances in Artificial Neural Network (ANN) technology exhibit great potential for solving such aerospace problems as optimization, control, pattern recognition, and signal processing. This project coordinates new and continuing investigations into applications of ANN technology. This year, it comprised four tasks: (1) implementing a Neural Network Simulator (NNS) to support neural network investigations; (2) solving message routing in dynamic topology networks; (3) performing vehicle-control-system fault detection and attitude estimation; and (4) applying ANN technology to estimation and identification techniques for determining spacecraft attitude. Author

**N93-18503#** Aerospace Corp., El Segundo, CA. Computer Systems Div.

**BARRIER SYNCHRONIZATION OF DISTRIBUTED-MEMORY ARCHITECTURES** **c62**

C. A. Lee *In its* Aerospace Sponsored Research 1 Dec. 1991 p 147-149 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

Barrier synchronization on a distributed-memory machine entails message-passing among the nodes participating in the barrier. In general, a node must tell one or more other nodes that it has arrived at the barrier, by sending one or more messages. It must then wait to receive one or more messages from other nodes so that it can deduce that all nodes have arrived at the barrier and it may proceed past the barrier. The differences among barrier algorithms are the number of necessary messages and the order in which the messages are sent and received, variables that directly affect the efficiency of the algorithm. The objective of this project was to develop the best possible barrier algorithms for distributed-memory architectures as the next logical step of previous work done on barrier synchronization over multistage interconnection networks for shared-memory machines. For this study, seven algorithms were implemented on Aerospace's Intel iPSC/860, which is a distributed-memory machine with eight nodes, each with 16 Mbyte of memory, based on the Intel i860 microprocessor running at 40 MHz. Author

**N93-18504#** Aerospace Corp., El Segundo, CA. Computer Systems Div.

**WRAPPING MATHEMATICAL TOOLS** **c64**

C. A. Landauer, K. L. Bellman, A. H. Bond, G. Chen-Ellis, A. Gillam, R. Lindell, M. T. OBrien, A. E. Quilici, and D. J. Strauss *In its* Aerospace Sponsored Research 1 Dec. 1991 p 149-152 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

The original objective of this project was to make mathematical tools available to a heterogeneous modeling environment by 'wrapping' them in expert interfaces that contain explicit, unambiguous descriptions of their use, capabilities, limitations, and behavior. Such wrapping is part of an organizational principle that makes all knowledge of system tools explicit. Our current objective is to apply wrapping concepts more generally, to develop a new methodology for constructing open, integrated software environments. The wrappings will describe all computational resources, not just mathematical tools, and, as we have learned, the wrapping descriptions must be separated according to different uses, since the different applications of resources require different information. Wrappings provide standard interfaces to a software resource and knowledge about the resource, so that other tools in the environment can interact with the wrapped resource, either to provide it with information or to use its information effectively. Several overviews or applications of the wrapping methodology have been presented recently. Author

**N93-18505#** Aerospace Corp., El Segundo, CA. Electronics and Sensors Div.

**ADVANCED VECTOR QUANTIZATION TECHNIQUES** **c64**

V. D. Vaughn and T. S. Wilkinson *In its* Aerospace Sponsored Research 1 Dec. 1991 p 152-155 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

Image compression continues to generate interest because the ability to collect large amounts of data at high rates has grown faster than transmission and storage capacities. In our continuing studies of image compression techniques, we focus on retaining image quality using adaptive, variable-rate compression techniques. Inherent in most image compression schemes is concern for the quality of the final product. The basis of our variable-rate compression scheme is a relatively new and promising technique called vector quantization (VQ). Vector quantization promises theoretical improvements over many current compression algorithms; more importantly, VQ provides a flexible configuration for variable-rate compression. The objective of this year's project was to show that vector quantization could be configured into a more efficient, high-quality compression system using variable-rate compression. Author

**N93-18506#** Aerospace Corp., El Segundo, CA. Advanced Orbital Systems Operations.

**WAVELET IMAGE ANALYSIS** **c61**

J. R. LaFrieda, L. A. Campbell, and M. Jankins *In its* Aerospace Sponsored Research 1 Dec. 1991 p 156-158 (For primary document see N93-18459 06-99)

Avail: CASI HC A01/MF A02

Wavelet analysis is a new signal analysis technique that has shown significant promise in applications such as image compression and object detection. It is based on the wavelet transform, which is a tool similar to the Fourier and Hadamard transforms. An important goal of this project was to develop an understanding of wavelet analysis and its relation to more classical ideas, such as Fourier and Gabor transforms. Specific technical objectives were as follows: (1) implement an in-house capability for the multi-resolution analysis of signals and images, allowing for flexibility in the selection of the mother wavelet f; (2) examine the applicability of wavelet transforms to selected signal processing tasks, in particular, compression, and image processing tasks, in particular, edge detection; and (3) devise and implement an adaptive compression scheme, using wavelet transforms, in which the finest level of detail varies from point to point. Author

**N93-18985#** Air Force Office of Scientific Research, Bolling AFB, Washington, DC.

**RESEARCH INTERESTS OF THE AIR FORCE OF SCIENTIFIC RESEARCH**

1 Oct. 1992 55 p Supersedes AFOSR-P-70-1 dated Oct. 1991

(Contract AF-AFOSR-TR-92-0984)

(AD-A258806; AFOSR-PAM-70-1; AFOSR-P-70-1) Avail: CASI HC A04/MF A01

Research Interests include: Aerospace Sciences: Structural Dynamics; Mechanics of Materials; Particulate Mechanics; Structural Mechanics; External Aerodynamics and Hypersonics; Internal Fluid Dynamics; Turbulence Prediction and Control; Unsteady and Separated Flows; Airbreathing Combustion; Space Power, Aeropropulsion Diagnostics. Chemistry and Materials Sciences: Chemical Reactivity and Synthesis; Polymer Chemistry, Inorganic Materials Chemistry; Electrochemistry; Theoretical Chemistry; Molecular Dynamics; Metallic Structural Materials; Ceramics and Nonmetallic Structural Materials. Physics and Electronics: Joint Services Electronics Program; Electronic Devices, Components, and Circuits; Photonic Devices and Systems; Quantum Electronic Solids; Semiconductor and Electromagnetic Materials; Photonic Physics; Optics; X-Ray Physics, Atomic and Molecular Physics; Plasma Physics. Life and Environmental Sciences: Neuroscience, Chronobiology, Perception and Recognition; Spatial Orientation; Cognition; Bioenvironmental Sciences; Terrestrial Sciences; Meteorology; Ionospheric Research; Optical and Infrared Environment; Space Sciences. Mathematical and Computer Sciences: Dynamics and Control; Physical Mathematics, Computational Mathematics; Optimization and Discrete Mathematics; Signal Processing, Probability, and Statistics; Software and Systems; Artificial Intelligence; Neural Computation Systems; Electromagnetics; and Education, Academic, and Industry Affairs. GRA

**N93-19390*#** University of Central Florida, Orlando.

**NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM**

Loren A Anderson, ed. and Carol Valdes, ed. (National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.) Sep. 1992 630 p

(Grant NGT-60002)

(NASA-CR-191004; NAS 1.26:191004) Avail: CASI HC A99/MF A06

This document is a collection of technical reports on research conducted by the participants in the 1992 NASA/ASEE Summer Faculty Fellowship Program at Kennedy Space Center (KSC). This was the eighth year that a NASA/ASEE program has been conducted at KSC. The 1992 program was administered by the University of Central Florida in cooperation with KSC. The program was operated under the auspices of the American Society for Engineering Education (ASEE) with sponsorship and funding from the Office of Educational Affairs, NASA Headquarters, Washington, D.C. The KSC program was one of nine such Aeronautics and Space Research Programs funded by NASA Headquarters in 1992. The basic common objectives are to further the professional knowledge, to stimulate an exchange of ideas, to enrich and refresh the research and teaching activities, and to contribute to the research objectives of the NASA centers. For individual titles, see N93-19391 through N93-19411.

**N93-19391*#** University of Central Florida, Orlando.

**USE OF CYCLIC CURRENT REVERSAL POLARIZATION VOLTAMMETRY FOR INVESTIGATING THE RELATIONSHIP BETWEEN CORROSION RESISTANCE AND HEAT-TREATMENT INDUCED VARIATIONS IN MICROSTRUCTURES OF 400 C MARTENSITIC STAINLESS STEELS** **c26**

John R. Ambrose *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 1-30 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

Software for running a cyclic current reversal polarization voltammagram has been developed for use with a EG&G Princeton Applied Research Model 273 potentiostat/galvanostat system. The program, which controls the magnitude, direction and duration of an impressed galvanostatic current, will produce data in ASCII spreadsheets (Lotus, Quattro) for graphical representation of CCRPV voltammograms. The program was used to determine differences in corrosion resistance of 440 C martenstic stainless steel produced as a result of changes in microstructure effected by tempering. It was determined that tempering at all temperatures above 400 F resulted in increased polarizability of the material, with the increased likelihood that pitting would be initiated upon exposure to marine environments. These results will be used in development of remedial procedures for lowering the susceptibility of these alloys toward the stress corrosion cracking experienced in bearings used in high pressure oxygen turbopumps used in the main engines of space shuttle orbiters. Author

**N93-19392*#** University of Central Florida, Orlando.

**HYDROGEN LEAK DETECTION IN THE SPACE SHUTTLE** **c16**

Ronald G Barile *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 31-68 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

This study focuses on a helium gas jet flowing into room air. Measurements of helium concentration and velocity in the jet-air mixture are reported. The objective is to learn about jet characteristics so that dynamically similar hydrogen leaks may be located in the Space Shuttle. The hazardous gas detection system (HGDS) in the mobile launch pad uses mass spectrometers to monitor the shuttle environment for leaks. The mass spectrometers are fed by long sample tubes which draw gas from the payload bay, mid body, aft engine compartment and external tank. The overall purpose of this study is to improve the HGDS especially in its potential for locating hydrogen leaks. A rapid-response leak detection experiment was designed, built, and tested, following on the work done in this program last summer. The apparatus included a Perkin Elmer MGA-1200 mass spectrometer and air velocity transducer, both monitored by a Macintosh IIFX computer using LabVIEW software. A jet of helium flowing into the lab air simulated a gas leak. Steady helium or hydrogen-nitrogen jets were logged for concentration and velocity, and the power spectral density of each was computed. Last year, large eddies and vortices were visually seen with Schlieren imaging, and they were detected in the time plots of the various instruments. The response time of the MGA-1200 was found in the range of 0.05 to 0.1 sec. Pulsed concentration waves were clearly detected at 25 cycles per sec by spectral analysis of MGA data. No peaks were detected in the power spectrum, so in the present study, 10 Hz bandwidth-averaged power levels were examined at regular frequency intervals. The practical consequences of last year's study are as follows: sampling frequency should be increased above the present rate of 1 sample per second so that transients could be observed and analyzed with frequency response methods. Many more experiments and conditions were observed in this second summer, including the effects of orifice diameter, jet velocity, sample tube design, radial effects, vertical flow, and low hydrogen concentrations (1 percent). A frequent observation was that the power spectrum, calculated from the Fourier transform of concentration fluctuations, gives a separate piece of information from concentration. Many of the tests suggest that power is high where mixing occurs at the helium-air interface. This fact is apparently independent of the concentration level, which could be high or low, but depends on the sample location relative to the jet (leak) origin, whereas high concentration may be due to a strong leak far away or a small leak close to the sample tube. If the power is low for any concentration level, this would signify helium is arriving at the sample tube by diffusion, not chaotic mixing caused by the jet interaction with air. The practical result is to propose a modification of the HGDL mass spectrometer data sampling and software so that sampling rates could be capable of observing at least 25 Hz fluctuations. Author

**N93-19393*#** University of Central Florida, Orlando. Dept. of Electrical Engineering.

**KINEMATIC ANALYSIS OF THE ARID MANIPULATOR** **c37**

Keith L Doty *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 69-80 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

The kinematic structure of the ARID manipulator lends itself to simple forward and inverse kinematics analysis. The purpose of this paper is to fully document and verify an existing analysis. The symbolic software package MATHEMATICA was used to produce and verify the equations presented here. In the analysis to follow, the standard Devenit-Hartenberg kinematic parameters of the ARID were employed. Author

**N93-19394*#** University of Central Florida, Orlando. Dept. of Electrical Engineering.

**CALIBRATION OF THE ARID ROBOT** **c37**

Keith L Doty *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 81-113 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

The author has formulated a new, general model for specifying the kinematic properties of serial manipulators. The new model kinematic parameters do not suffer discontinuities when nominally parallel adjacent axes deviate from exact parallelism. From this new theory the author develops a first-order, lumped-parameter, calibration-model for the ARID manipulator. Next, the author develops a calibration methodology for the ARID based on visual and acoustic sensing. A sensor platform, consisting of a camera and four sonars attached to the ARID end frame, performs calibration measurements. A calibration measurement consists of processing one visual frame of an accurately placed calibration image and recording four acoustic range measurements. A minimum of two measurement protocols determine the kinematics calibration-model of the ARID for a particular region: assuming the joint displacements are accurately measured, the calibration surface is planar, and the kinematic parameters do not vary rapidly in the region. No theoretical or practical limitations appear to contra-indicate the feasibility of the calibration method developed here. Author

**N93-19395*#** University of Central Florida, Orlando. Dept. of Electrical Engineering.

**ARID RELATIVE CALIBRATION EXPERIMENTAL DATA AND ANALYSIS c37**

Keith L Doty *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 115-142 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

Several experiments measure the orientation error of the ARID end-frame as well as linear displacements in the Orbiter's y- and z-axes. In each experiment the position of the ARID on the trolley is fixed and the manipulator extends and retracts along the Orbiter's y-axis. A sensor platform consisting of four sonars arranged in a '+' pattern measures the platform pitch about the Orbiter's y-axis (angle b) and yaw about the Orbiter's x-axis (angle alpha). Corroborating measurements of the yaw error were performed using a carpenter's level to keep the platform perpendicular to the gravity vector at each ARID pose being measured. Author

**N93-19396*#** Purdue Univ., Indianapolis, IN. Agricultural Engineering Dept.

**WATER QUALITY MODELING USING GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA c45**

Bernard A Engel *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 143-170 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

Protection of the environment and natural resources at the Kennedy Space Center (KSC) is of great concern. The potential for surface and ground water quality problems resulting from non-point sources of pollution was examined using models. Since spatial variation of parameters required was important, geographic information systems (GIS) and their data were used. The potential for groundwater contamination was examined using the SEEPAGE (System for Early Evaluation of the Pollution Potential of Agricultural Groundwater Environments) model. A watershed near the VAB was selected to examine potential for surface water pollution and erosion using the AGNPS (Agricultural Non-Point Source Pollution) model. Author

**N93-19397*#** Michigan Univ., Ann Arbor. Dept. of Electrical Engineering.

**NETWORK PROBLEM THRESHOLD c32**

Raghvendra Gejji, R. *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 171-198 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

Network transmission errors such as collisions, CRC errors, misalignment, etc. are statistical in nature. Although errors can vary randomly, a high level of errors does indicate specific network problems, e.g. equipment failure. In this project, we have studied the random nature of collisions theoretically as well as by gathering statistics, and established a numerical threshold above which a network problem is indicated with high probability. Author

**N93-19398*#** Oklahoma State Univ., Stillwater. Dept. of Electrical and Computer Engineering.

**REDUNDANT DRIVE CURRENT IMBALANCE PROBLEM OF THE AUTOMATIC RADIATOR INSPECTION DEVICE (ARID) c37**

Carl D. Latino *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 199-228 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A05

The Automatic Radiator Inspection Device (ARID) is a 4 Degree of Freedom (DOF) robot with redundant drive motors at each joint. The device is intended to automate the labor intensive task of space shuttle radiator inspection. For safety and redundancy, each joint is driven by two independent motor systems. Motors driving the same joint, however, draw vastly different currents. The concern was that the robot joints could be subjected to undue stress. It was the objective of this summer's project to determine the cause of this current imbalance. In addition it was to determine, in a quantitative manner, what was the cause, how serious the problem was in terms of damage or undue wear to the robot and find solutions if possible. It was concluded that most problems could be resolved with a better motor control design. This document discusses problems encountered and possible solutions. Author

**N93-19399*#** University of Central Florida, Orlando. Chemistry Dept.

**CHEMICAL CHARACTERIZATION OF SOME AQUEOUS LEACHATES FROM CROP RESIDUES IN 'CELSS' c51**

Brooks C. Madsen *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 229-259 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

Aqueous leachate samples prepared from crop residues that are produced as a component of the Controlled Ecological Life Support System program designed to support long duration space missions have been compared and general chemical characterization has been accomplished. Solid phase extraction and high performance liquid chromatography were used to accomplish comparisons based on chromatographic and ultraviolet absorption properties of the components that are present. Specific compounds were not identified, however, general composition related to the presence of phenol-like compounds was explored. Author

**N93-19400*#** Puerto Rico Univ., Mayaguez. Dept. of Chemical Engineering.

**EVALUATION OF ULTRASONIC CAVITATION OF METALLIC AND NON-METALLIC SURFACES c71**

Narinder K. Mehta *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 261-317 (For primary document see N93-19390 06-99)
Avail: CASI HC A04/MF A06

1,1,2 trichloro-1,2,2 trifluoro ethane (CFC-113) commercially known as Freon-113 is the primary test solvent used for validating the cleaned hardware at the Kennedy Space Center (KSC). Due to the ozone depletion problem, the current United States policy calls for the phase out of Freons by 1995. NASAs chlorofluorocarbon (CFC) replacement group at KSC has opted to use water as a replacement fluid for the validation process since water is non-toxic, inexpensive, and is environmentally friendly. The replacement validation method calls for the ultrasonification of the small parts with water at 52 C for a cycle or two of 10 min duration wash using commercial ultrasonic baths. In this project, experimental data was obtained to assess the applicability of the proposed validation method for any damage of the metallic and non-metallic surfaces resulting from ultrasonic cavitation. Author

**N93-19401*#** Baylor Univ., Dallas, TX. Dept. of Engineering and Computer Science.

**AUTOMATICALLY CALIBRATING ADMITTANCES IN KATE'S AUTONOMOUS LAUNCH OPERATIONS MODEL c15**

Steve Morgan *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 319-362 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

This report documents a 1000-line Symbolics LISP program that automatically calibrates all 15 fluid admittances in KATE's Autonomous Launch Operations (ALO) model. (KATE is Kennedy Space Center's

Knowledge-based Autonomous Test Engineer, a diagnosis and repair expert system created for use on the Space Shuttle's various fluid flow systems.) As a new KATE application, the calibrator described here breaks new ground for KSC's Artificial Intelligence Lab by allowing KATE to both control and measure the hardware she supervises. By automating a formerly manual process, the calibrator: (1) saves the ALO model builder untold amounts of labor; (2) enables quick repairs after workmen accidently adjust ALO's hand valves; and (3) frees the modeler to pursue new KATE applications that previously were too complicated. Also reported are suggestions for enhancing the program: (1) to calibrate ALO's TV cameras, pumps, and sensor tolerances; and (2) to calibrate devices in other KATE models, such as the shuttle's LOX and Environment Control System (ECS).

Author

**N93-19402*#** Christian Brothers Coll., Memphis, TN. Dept. of Chemical Engineering.

**MATERIAL SELECTION AND EVALUATION OF NEW ENCAPSULATION COMPOUNDS FOR ELECTRIC CABLES FOR LAUNCH SUPPORT SYSTEM** **c27**

Asit K. Ray *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 363-389 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

Eight urethane compounds were evaluated as possible replacement for the existing encapsulating compoounds for electrical cables for the Launch Support System at Kennedy Space Center (KSC). The existing encapsulating compound, PR-1535, contains the curative MOCA 4-4'-Methylene-BIS (2-chloroaniline), which is a suspect carcinogen and hence may be the subject of further restrictions of its use by the Occupational Safety and Health Administration (OSHA). The samples made in the configuration of cable joints and in the form of disks were evaluated for flammability and hypergolic compatibility. These also underwent accelerated weatherability tests that measured the residual hardness of the exposed samples. Three candidates and the existing compound passed the hardness test. Of these, only one candidate and the existing compound passed the flammability test. The thermal and hydrolytic stability (weatherability) of these samples was studied using thermogravimetric analysis (DSC) techniques. The TMA and DSC data correlated with the residual hardness data; whereas, the TGA data showed no correlation. A hypergolic compatibility test will be conducted on the compound V-356-HE80, which passed both the flammability and accelerated weatherability tests. Author

**N93-19403*#** Wisconsin Univ., Green Bay. Dept. of Physics.

**DETERMINATION AND REPRESENTATION OF ELECTRIC CHARGE DISTRIBUTIONS ASSOCIATED WITH ADVERSE WEATHER CONDITIONS** **c47**

John T. Rompala *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 391-420 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

Algorithms are presented for determining the size and location of electric charges which model storm systems and lightning strikes. The analysis utilizes readings from a grid of ground level field mills and geometric constraints on parameters to arrive at a representative set of charges. This set is used to generate three dimensional graphical depictions of the set as well as contour maps of the ground level electrical environment over the grid. The composite, analytic and graphic package is demonstrated and evaluated using controlled input data and archived data from a storm system. The results demonstrate the packages utility as: an operational tool in appraising adverse weather conditions; a research tool in studies of topics such as storm structure, storm dynamics, and lightning; and a tool in designing and evaluating grid systems. Author

**N93-19404*#** Portland State Univ., OR. Computer Science Dept.

**DEVELOPMENT OF A TASK ANALYSIS TOOL TO FACILITATE USER INTERFACE DESIGN** **c61**

Jean C. Scholtz *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 421-450 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

A good user interface is one that facilitates the user in carrying out his task. Such interfaces are difficult and costly to produce. The most important aspect in producing a good interface is the ability to communicate to the software designers what the user's task is. The Task Analysis Tool is a system for cooperative task analysis and specification of the user interface requirements. This tool is intended to serve as a guide to development of initial prototypes for user feedback. Author

**N93-19405*#** University of Central Florida, Orlando. Dept. of Industrial Engineering and Management Systems.

**TRAINING EVALUATION FINAL REPORT** **c80**

Jose A. Sepulveda *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 451-458 (For primary document see N93-19390 06-99)

Avail: CASI HC A02/MF A06

In the area of management training, 'evaluation' refers both to the specific evaluation instrument used to determine whether a training effort was considered effective, and to the procedures followed to evaluate specific training requests. This report recommends to evaluate new training requests in the same way new procurement or new projects are evaluated. This includes examining training requests from the perspective of KSC goals and objectives, and determining expected ROI of proposed training program (does training result in improved productivity, through savings of time, improved outputs, and/or personnel reduction?). To determine whether a specific training course is effective, a statement of what constitutes 'good performance' is required. The user (NOT the Training Branch) must define what is 'required level of performance'. This 'model' will be the basis for the design and development of an objective, performance-based, training evaluation instrument. Author

**N93-19406*#** University of Central Florida, Orlando. Dept. of Industrial Engineering and Management Systems.

**NEEDS ASSESSMENT FINAL REPORT** **c80**

Jose A. Sepulveda *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 459-481 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

The stated purposes of the Management Science Faculty Fellowship Project were to: (1) provide a comprehensive analysis of KSC management training for engineers and other management professionals from project/program lead through executive levels; and (2) development of evaluation methodologies which can be used to perform ongoing program-wide course-to-course assessments. This report will focus primarily in the first stated purpose for the project. Ideally, the analysis of KSC management training will build in the current system and efficiently propose improvements to achieve existing goals and objectives while helping to identify new visions and new outcomes for the Center's Management Training Mission. Section 2 describes the objectives, approach, and specific tasks used to analyze KSC's Management training System. Section 3 discusses the main conclusions derived from an analysis of the available training data. Section 4 discusses the characteristics and benefits envisioned for a Management Training System. Section 5 proposes a Training System as identified by the results of a Needs Assessment exercise conducted at KSC this summer. Section 6 presents a number of recommendations for future work. Author

**N93-19407*#** North Carolina Univ., Charlotte. Dept. of Engineering Technology.

**STUDY AND DEVELOPMENT OF AN AIR CONDITIONING SYSTEM OPERATING ON A MAGNETIC HEAT PUMP CYCLE (DESIGN AND TESTING OF FLOW DIRECTORS)** **c34**

Pao-Lien Wang *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 483-500 (For primary document see N93-19390 06-99)

Avail: CASI HC A03/MF A06

This report describes the fabrication, design of flow director, fluid flow direction analysis and testing of flow director of a magnetic heat pump. The objectives of the project are: (1) to fabricate a demonstration magnetic heat pump prototype with flow directors installed; and (2) analysis and testing of flow director and to make sure working fluid loops flow through correct directions with minor mixing. The prototype was fabricated and tested at the Development Testing Laboratory of Kennedy Space Center. The magnetic heat pump uses rear earth metal plates rotate in and out of a magnetic field in a clear plastic housing with water flowing through the

rotor plates to provide temperature lift. Obtaining the proper water flow direction has been a problem. Flow directors were installed as flow barriers between separating point of two parallel loops. Function of flow directors were proven to be excellent both analytically and experimentally. Author

**N93-19408*#** New York Inst. of Tech., NY. Electrical Engineering Dept.
**DESIGN AND EVALUATION OF FDDI FIBER OPTICS NETWORKFOR ETHERNETS, VAX'S AND INGRAPH WORK STATIONS** **c74**
M. Chris Wernicki *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 501-529 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

The purpose of this project is to design and evaluate the FDDI Fiber Optics Network for Ethernets, VAX's, and Ingraph work stations. From the KSC Headquarters communication requirement, it would be necessary to develop the FDDI network based on IEEE Standards outlined in the ANSI X3T9.5, Standard 802.3 and 802.5 topology - direct link via intermediate concentrator and bridge/router access. This analysis should examine the major factors that influence the operating conditions of the Headquarters Fiber plant. These factors would include, but are not limited to the interconnecting devices such as repeaters, bridges, routers and many other relevant or significant FDDI characteristics. This analysis is needed to gain a better understanding of overall FDDI performance. Author

**N93-19409*#** University of Central Florida, Orlando. Dept. of Electrical and Computer Engineering Technology.
**INVESTIGATION OF THE BANDWIDTH OF MULTIMODE OPTICAL FIBERS USED WITH 1550-nm LED AND LASER SOURCES** **c74**
Preston A. White, III *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 531-559 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

Multimode optical fibers are not intended to be used with 1550-nm sources; however, it is desirable to utilize 1300/1550-nm wavelength division multiplexing (WDM) on some multimode fibers at Kennedy Space Center (KSC). No information from fiber vendors nor from the literature is available to support this use. Preliminary studies at KSC have suggested that these fibers might be usable at 1550-nm if the fibers possessed enough bandwidth when sourced by LEDs. Detailed bandwidth studies were made on 12 multimode fibers using 1300- and 1550-nm lasers and LEDs. The results showed that the modal bandwidth at 1550-nm was about 50 percent of the 1300-nm value and that the chromatic dispersion could be predicted by extrapolating the vendor's specifications for wavelengths outside the 1550-nm region. Utilizing these data, predictions of the fiber's optical bandwidth were accurately made. Problems with launch conditions and possible differential attenuation at connectors was noted at 1300-nm but was less significant at 1550-nm. It appears that the multimode fibers studied will offer adequate performance in the 1550-nm region for a number of current KSC needs. Studies of additional fibers are encouraged to gain more confidence and better understanding of the 1550-nm bandwidth of KSC's multimode optical fibers before committing to 1300/1550-nm WDM. Author

**N93-19410*#** University of Central Florida, Orlando. Dept. of Materials Science and Engineering.
**A LOGISTICS AND POTENTIAL HAZARD STUDY OF PROPELLANT SYSTEMS FOR A SATURN 5 DERIVED HEAVY LIFT (THREE-STAGE CORE) LAUNCH VEHICLE** **c20**
E. Dow Whitney *In its* NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 561-591 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A06

The Bush Administration has directed NASA to prepare for a return to the Moon and on to Mars - the Space Exploration Initiative. To meet this directive, powerful rocket boosters will be required in order to lift payloads that may reach the half-million pound range into low earth orbit. In this report an analysis is presented on logistics and potential hazards of the propellant systems envisioned for future Saturn 5 derived heavy lift launch vehicles. In discussing propellant logistics, particular attention has been given to possible problems associated with procurement, transportation, and storage of RP-1, HL2, and LOX, the heavy lift launch vehicle propellants. Current LOX producing facilities will need to be expanded and propellant storage and some support facilities will require relocation if current Launch Pads 39A and/or 39B are to be used for future heavy noise-abatement measures. Included in the report is a discussion of suggested additional studies, primarily economic and environmental, which should be undertaken in support of the goals of the Space Exploration Initiative. Author

**N93-19411*#** University of Western Carolina, Cullowhee, NC. Mathematics and Computer Science Dept.
**HURRICANE RISK ASSESSMENT TO ROLLBACK OR RIDE OUT A COST VERSUS LOSS DECISION MAKING APPROACH** **c47**
Richard A. Wohlman *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program Sep. 1992 p 593-632 (For primary document see N93-19390 06-99)
Avail: CASI HC A03/MF A05

The potential exists that a hurricane striking the Kennedy Space Center while a Space Shuttle is on the pad. Winds in excess of 74.5 knots could cause the failure of the holddown bolts bringing about the catastrophic loss of the entire vehicle. Current plans call for the rollback of the shuttle when winds of that magnitude are forecast to strike the center. As this is costly, a new objective method for making rollback/rideout decisions based upon Bayesian Analysis and economic cost versus loss is presented. Author

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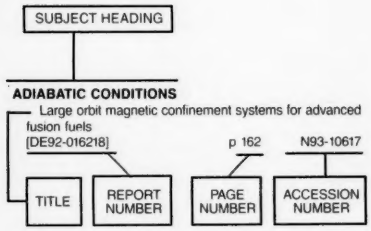


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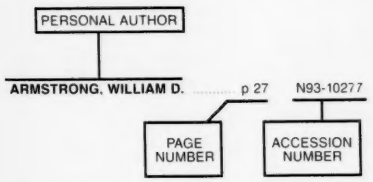


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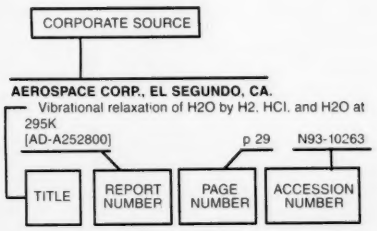


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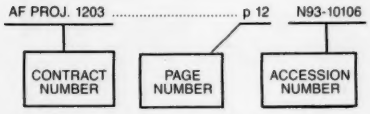


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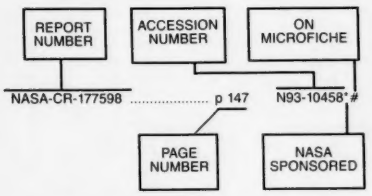


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# Appendix

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